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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXIV.] JULY 15, 1936 [No. 1.

The Synthesis of Pseudodithiobiurets and Their Derivatives

H. G. UNDERWOOD and F. B. DAINS, Department of Chemistry, University of Kansas.

ARYL monopseudodithiobiurets of the type RNHCSNHC (SR'):NH (R represents aryl groups; R' alkyl) are readily prepared by the decomposition of the sulphate salt of a pseudothiourea with sodium carbonate and immediate reaction of the pseudothiourea with a mustard oil,

$$H_2NC(SR'):NH + RNCS = RNHCSNHC(SR'):NH.$$

In previous work[1] the alkyl halide addition product of thiourea was decomposed with potassium hydroxide. Diaryl monopseudodithiobiurets of the type RN:C(SR')NHCSNHR (R represents aryl groups; R' alkyl) were prepared by the reaction of a mustard oil with a pseudothiourea in ether solution. The reaction is smooth and the yields are practically quantitative, confirming the work of Johnson.[1]

Johnson found that a monopseudodithiobiuret is converted to a dipseudodithiobiuret by the action of alkyl halides; methyl iodide being used as one of the alkylating agents. Methyl sulphate reacts very smoothly in acetone solution for the conversion of a monopseudodithiobiuret into a dipseudodithiobiuret. The sulphate salt first formed is easily decomposed, giving the free base, on treating a cold aqueous solution with sodium carbonate, the yield being quantitative.

Pseudodithiobiurets thiohydrolyze readily on warming an alcoholic solution with potassium hydrosulphide. According to the method of Olin and Dains[2] hydrogen sulphide is slowly bubbled through the alcoholic solution. Good results were obtained omitting the use of hydrogen sulphide; thus 1, 5-diphenyldithiobiuret previously prepared by Olin and Dains was obtained by thiohydrolysis of the

1. Johnson, Am. Chem. J., 30, 167 (1903).
2. Olin, Dains, J. Am. Chem. Soc., 52, 3326 (1930).

2-thiolmethyl derivative using only potassium hydrosulphide as the thiohydrolytic agent.

Fusion of 1, 5-diphenyl-2-thiolmethyl-pseudodithiobiuret with phenylhydrazine yielded diphenyl-thiosemicarbazide corresponding to the results obtained by Johnson and Bristol[3] from 1, 5-diaryl-pseudodithiobiurets. The 1, 5-díaryl-dípseudodithiobiurets were found to react with hydrazine, phenylhydrazine and substituted phenylhydrazines with the liberation of mercaptan to yield 1, 2, 4-triazols of the type $R'\overline{NC(:NR)NHC(NR)NH}$ (R represents aryl groups; R' hydrogen or aryl groups). Triazols of the above type are also formed by the reaction of hydrazines on α, α'-diaryl-thiurets. Ring closure of the substituted guanido-arylthioureas first formed, to the 1, 2, 4-triazols results on treatment with alkali.

New thiurets were prepared by the method of Fromm and Schneider[4] according to the reaction:

$$RNHCSNHCSNH_2 + I_2 = \overline{SC(:NR)NHC(S)}:NH.HI + HI$$

While thiurets previously reported have all been of the mono-aryl type our work shows that diaryl thiurets of the type $\overline{SC(:NR)NHC(S)}:NR$ are readily prepared from 1, 5-diaryl-dithiobiurets; thus 1, 5-diphenyl-dithiobiuret on oxidation in alcoholic solution with iodine yielded 1, 5-diphenyl-thiuret hydroiodide.

Condensation of dithiobiurets with acetone and benzaldehyde to form keturets and aldurets was affected by means of dry hydrogen chloride according to the method of Fromm.[5]

EXPERIMENTAL

Synthesis of Mono- and Dipseudodithiobiurets

1 - Phenyl - 4 - thiolmethyl - pseudodithiobiuret, $C_6H_5NHCSNHC(SCH_3):NH$.—This was formed in good yield when methyl isothiourea sulphate dissolved in an alcohol-water mixture (1 + 1) at 70° was allowed to react gradually with phenyl mustard oil after liberation of the free base with sodium carbonate solution. The product on recrystallization from alcohol gave white prism-like crystals melting at 124° (reported 125°).[1] Other pseudodithiobiurets from an aryl mustard oil and an alkyl isothiourea sulphate were prepared by this method.

1. Johnson, Am. Chem. J., 30, 167 (1903).
3. Johnson, Bristol, Am. Chem. J., 30, 173 (1903).
4. Fromm, Schneider, Ann, 348, 161 (1906).
5. Fromm, Ann., 275, 20 (1893).

Thiohydrolysis of 1-Phenyl-4-thiolmethyl-pseudodithiobiuret to Phenyldithiobiuret, $C_6H_5NHCSNHCSNH_2$.—The thio ether (4 g.) was dissolved in hot alcohol (50 cc.) together with 2.5 g. of potassium hydrosulphide in 5 cc. of water. Hydrogen sulphide was passed into the boiling solution for an hour. The hot solution was filtered and acidified with acetic acid. On cooling, delicate white, feather-like crystals of phenyldithiobiuret melting at 184° (reported 184°)[6] separated.

Analyses: Calcd. for $C_8H_9N_3S_2$:N, 19.89.

Found: N, 19.49; 19.79.

1 - m - Tolyl-4-thiolmethyl - pseudodithiobiuret, $C_7H_7NHCSNHC(SCH_3):NH$.—Methyl isothiourea sulphate when treated with m-tolyl mustard oil and sodium carbonate solution yielded the pseudodithiobiuret. Crystallized from alcohol, it then melted at 87°.

Analyses: Calcd. for $C_{10}H_{13}N_3S_2$:N, 17.51.

Found: N, 17.23; 17.25.

1-p-Bromophenyl-4-thiolmethyl-pseudodithiobiuret, $BrC_6H_4NHCSNHC(SCH_3):NH$.—This was prepared from p-bromophenyl isothiocyanate and methyl isothiourea sulphate. Purified from alcohol, it melted at 154°.

Analyses: Calcd. for $C_9H_{10}N_3S_2Br$: N, 13.81.

Found: N, 13.50; 13.44.

1 - p-Bromophenyl-4-thiolethyl - pseudodithiobiuret, $BrC_6H_4NHCSNHC(SC_2H_5):NH$.—This product, prepared from p-bromophenyl isothiocyanate and ethyl isothiourea sulphate, melted at 147°.

Analyses: Calcd. for $C_{10}H_{12}BrN_3S_2$: N, 13.20.

Found: N. 13.12; 13.24.

1-Phenyl - 5 - allyl - 2 - thiolmethyl-pseudodithiobiuret, $C_6H_5N:C(SCH_3)NHCSNHCH_2CH:CH_2$.—On spontaneous evaporation of a solution of molecular proportions (0.05 moles) of allyl mustard oil and the methyl ether of phenylthiourea in 75 cc. of ether, a crystalline body was obtained together with gummy material. The crystals were separated by the addition of alcohol and filtering. Recrystallized from alcohol, the compound melted at 100-101°.

Analyses: Calcd. for $C_{12}H_{15}N_3S_2$: N, 15.85.

Found: N, 15.79; 15.79.

Thiohydrolysis of 1,5-Diphenyl-2-thiolmethyl-pseudodithiobiuret; 1, 5-Diphenyl-dithiobiuret, $C_6H_5NHCSNHCSNHC_6H_5$.—The thio ether (18 g.) prepared by the method of Johnson[1] was dissolved in hot alcohol (100 cc.) together with 10 g. of potassium hydrosulphide

1. Johnson, Am. Chem. J., 30, 167 (1903).
6. Fromm, Ann., 275, 33 (1893).

in 20 cc. of water. The hot solution after refluxing for one hour was filtered and acidified with acetic acid. On cooling, fine needles of 1, 5-diphenyl-dithiobiuret melting at 149° (reported 149°)[2] separated.

1 - Phenylmethyl - 5 - phenyl-dithiobiuret, $C_6H_5(CH_3):NCSNHC\ SNHC_6H_5$. — Thiohydrolysis of 1, 5 - diphenyl - 1 - methyl - 2-thiolmethyl-pseudodithiobiuret yielded crystals which melted at 126°.

Analyses: Calcd. for $C_{15}H_{15}N_3S_2$: N, 13.95.

Found: N, 13.36; 13.69.

1 - p - Bromophenyl - 5 - phenyl-4-thiolmethyl-pseudodithiobiuret, $BrC_6H_4NHCSNHC(SCH_3):NC_6H_5$.—On allowing an ether solution of phenyl thiolmethylpseudothiourea (0.02) and p-bromophenyl isothiocyanate (0.02 mol.) to evaporate spontaneously there was obtained a crystalline body which on recrystallization from alcohol melted at 140-141°.

Analyses: Calcd. for $C_{15}H_{14}BrN_3S_2$: N, 11.05.

Found: N, 10.98; 10.97.

1 - p - Iodophenyl - 5 - phenyl - 4 - thiolmethyl-pseudodithiobiuret, $IC_6H_4NHCSNHC(SCH_3):NC_6H_5$.—The product obtained by allowing phenyl thiolmethylpseudothiourea to react with p-iodophenyl isothiocyanate crystallized from hot alcohol in the form of prisms melting at 126°.

Analyses: Calcd. for $C_{15}H_{14}IN_3S_2$: N, 9.84.

Found: N, 9.90; 9.77.

1-m-Tolyl-5-phenyl-4-thiolmethyl-pseudodithiobiuret, $C_7H_7NHC\ SNHC(SCH_3):NC_6H_5$.—Light yellow, transparent plate-like crystals melting at 87° resulted on allowing m-tolyl isothiocyanate to react with phenyl thiolmethylpseudothiourea dissolved in ether.

Analyses: Calcd. for $C_{16}H_{17}N_3S_2$: N, 13.33.

Found: N, 13.34; 13.48.

1 - p - Tolyl-5-phenyl-4-methyl-pseudothiobiuret, $C_7H_7NHCONC(SCH_3):NC_6H_5$. — p-Tolyl isocyanate (0.03 mol.) reacted with phenyl thiolmethylpseudothiourea with the evolution of heat. The clear, viscous product first formed solidified on standing. Washed with ether and recrystallized from alcohol the methyl thiobiuret melted at 109-110°.

Analyses: Calcd. for $C_{15}H_{16}N_3OS$: N, 14.09.

Found: N, 13.98; 14.01.

1, 5-Diphenyl - 2, 4 - thiolmethyl - dipseudodithiobiuret, $C_6H_5N:C(SCH_3)NHC(SCH_3):NC_6H_5$. — Methyl sulphate (0.1 mol.) was slowly added to a solution of 1, 5-diphenyl-2-thiolmethyl-pseudo-

2. Olin, Dains, J. Am. Chem. Soc., 52, 3326 (1930).

dithiobiuret (0.1 mol.) in acetone (100 cc.) and the reaction mixture refluxed on the water-bath for two hours. The light-yellow, gummy residue obtained on evaporation of the acetone, after dissolving in alcohol and treatment with sodium carbonate, yielded an oil which soon solidified. The product on recrystallization from alcohol melted at 104° (reported 103-104°).[1]

Analyses: Calcd. for $C_{16}H_{17}N_3S_2$: N, 13.33.

Found: N, 13.24.

1 - Phenyl - 2 -, 4 - thiolmethyl - dipseudodithiobiuret, $C_6H_5N{:}C(SCH_3)NHC(SCH_3){:}NH$.—The free base obtained by the reaction of methyl sulphate with the 4-thiolmethyl derivative crystallized from hot alcohol in the form of long needle-like prisms melting at 123°. A mixed melting point with the starting product was 99-101°.

Analyses: Calcd. for $C_{10}H_{13}N_3S_2$: N, 17.54.

Found: N, 17.27; 17.60.

SYNTHESIS OF 1, 2, 4-TRIAZOLS

Fusion of Phenylhydrazine with 1, 5 - Diphenyl - 2 - thiolmethyl-pseudodithiobiuret; Formation of Diphenylthiosemicarbazide, $C_6H_5NHNHCSNHC_6H_5$.—Six grams of the pseudodithiobiuret and 2.5 g. of phenylhydrazine were fused together in an eight-inch Pyrex test tube. The odor of mercaptan was first noted at 90° and after two hours at 110° the reaction mixture had again solidified. The solid recrystallized from alcohol in the form of short, colorless needles melting at 176°. Mixed with diphenylthiosemicarbazide the melting point was not lowered.

1-Phenyl-3, 5-phenylimino-1, 2, 4-triazol, $C_6H_5\overline{NC(:NC_6H_5)NHC(NH):NC_6H_5}$.—Four grams of phenylhydrazine mixed with 10.5 g. of 1, 5-diphenyl-2, 4-thiolmethyl-dipseudodithiobiuret first reacted with the liberation of mercaptan at 110°. The reaction temperature was maintained between 110° and 140° until the odor of mercaptan was no longer noticed. The fusion product after two crystallizations from alcohol gave delicate white needles melting at 153-154°. A negative test for sulphur and the analysis (Dumas method) for nitrogen indicated formation of the triazol according to the following reaction:

$$C_6H_5N{:}C(SCH_3)NHC(SCH_3){:}NC_6H_5 + C_6H_5NHNH_2 =$$

$$C_6H_5\overline{NC(:NC_6H_5)NHC(NC_6H_5):NH} + 2CH_3SH$$

Analyses: Calcd. for $C_{20}H_{17}N_5$: N, 21.43.

Found: N, 21.59.

1. Johnson, Am. Chem. J., 30, 167 (1903).

The salt formed with sulphuric acid melted at 190°. Analysis by titration of an alcoholic solution of the salt with standard base indicated the addition of one mol. of H_2SO_4.

Analyses: Calcd. for addition of one mol. H_2SO_4: 23.06.

Found: 24.96.

Phenyl - anilguanido - phenylthiourea, $C_6H_5N : C(NHNHC_6H_5)NHCSNHC_6H_5$.—A flocculent white precipitate resulted on refluxing an alcoholic solution containing molecular proportions of 1, 5-diphenyl-thiuret hydroiodide and phenylhydrazine on the water-bath. The reaction product was dissolved in a large quantity of hot alcohol and filtered free from sulphur. On cooling, white needles of the substituted thiourea melting at 167° separated.

Analyses: Calcd. for $C_{20}H_{19}N_5S$: N, 19.39.

Found: N, 19.32.

1-Phenyl-3, 5-phenylimino-1, 2, 4-triazol from Phenyl-anilguanido-phenylthiourea.—Ring closure to the 1, 2, 4-triazol resulted on warming three grams of phenyl-anilguanido-phenylthiourea in an alcoholic sodium hydroxide solution (1 g. NaOH, 5 cc. water, 25 cc. alcohol) for one hour at water-bath temperature. The needle-like crystals of the triazol which separated on cooling melted at 153-154°. A mixed melting point of this product with the triazol from 1, 5-diphenyl-2, 4-thiolmethyl-dipseudodithiobiuret showed no lowering.

Analyses: Calcd. for $C_{20}H_{17}N_5$: N, 21.43.

Found: N, 21.36.

1-p-Bromophenyl-3, 5-phenylimino-1, 2, 4-triazol,

$$BrC_6H_4\overline{NC(:NC_6H_5)NHC(NC_6H_5):NH}.$$

This triazol was obtained on fusion of molecular proportions of 1, 5-diphenyl-2, 4-thiolmethyl-dipseudodithiobiuret and p-bromophenylhydrazine. Mercaptan was first liberated at 100° and on heating at 110° for several hours the odor of mercaptan was no longer noticed. Crystallized from alcohol in the form of fine white needles, it then melted at 190°.

Analyses: Calcd. for $C_{20}H_{16}BrN_5$: Br, 19.68.

Found: Br, 19.95.

1-(o-Tolyl)-3, 5-phenylimino-1, 2, 4-triazol,

$$C_7H_7\overline{NC(:NC_6H_5)NHC(NH):NC_6H_5}.$$

Molecular proportions of o-tolylhydrazine and 1, 5-diphenyl-2, 4-thiolmethyl-dipseudodithiobiuret were allowed to react for several

hours at 110°. The resulting triazol recrystallized from alcohol in the form of delicate white needles melted at 174°. A negative test for sulphur and the analysis indicated formation of the triazol.

Analyses: Calcd. for $C_{21}H_{19}N_5$: N, 20.53.

Found: N, 20.61.

1-(p-Tolyl)-3, 5-phenylimino-1, 2, 4-triazol,

$$C_7H_7\overline{NC(:NC_6H_5)NHC(NC_6H_5):NH}.$$

—This triazol melting at 161° was obtained from p-tolylhydrazine and the above dipseudodithiobiuret.

Analyses: Calcd. for $C_{21}H_{19}N_5$: N, 20.53.

Found: N, 20.40.

3, 5-Phenylimino-1, 2, 4-triazol, $\overline{HNC(:NC_6H_5)NHC(NH)}:NC_6H_5$.—Hydrazine [0.02 mol. of hydrazine sulphate and potassium hydroxide] and 1, 5-diphenyl-2, 4-thiolmethyl-dipseudodithiobiuret in 100 cc. of alcohol were refluxed at water-bath temperature for four hours. Mercaptan was slowly evolved during the reaction and a white flocculent mass of fine white needlelike crystals separated from the reaction solution. Recrystallized from alcohol, it then melted at 250-251° and gave a negative test for sulphur.

Analyses: Calcd. for $C_{14}H_{13}N_5$: N, 27.89.

Found: N, 27.72.

With concentrated sodium hydroxide solution and also with bleaching powder a deep red coloration was observed. The formation of azo compounds is typical of urazols of this type.[7]

3, 5-Phenylimino-1, 2, 4-triazol from α, α'*-Diphenyl-thiuret Hydroiodide.*—Hydrazine sulphate (0.02 mol.) and α, α'-diphenyl-thiuret hydroiodide (0.01 mol.) in alcohol (50 cc.) were refluxed together for one hour. An excess of alcoholic sodium hydroxide was then added and the reaction mixture further refluxed for one half hour. The solution was filtered while hot from precipitated sulphur and on cooling the crystals which separated melted at 244°. A slight test for sulphur, the melting point 6° lower than for the above triazol and the low nitrogen analysis indicated traces of the thiuret.

Analyses: Calcd. for $C_{14}H_{13}N_5$: N, 27.89.

Found: N, 27.26.

The Benzoyl Derivative of 3, 5-Phenylimino-1, 2, 4-triazol.—To several grams of the triazol dissolved in pyridine was added an

7. Pellizzari, Gazetta chimica italiana, 21, II, 141 (1891).

excess of three molecular proportions of benzoyl chloride. The reaction mixture warmed spontaneously and on addition of water an oily product separated which solidified on cooling. The benzoyl derivative crystallized from alcohol in the form of light yellow needles melting at 136°. Analysis indicated formation of a monobenzoyl derivative.

Analyses: Calcd. for $C_{21}H_{17}N_5O$: N, 19.72.

Found: N, 19.54.

Reaction of p-Tolyl Isocyanate with 3, 5-Phenylimino-1, 2, 4-triazol.—Several grams of the triazol were suspended in water-free ether and an excess of three molecular proportions of p-tolyl isocyanate added. Complete solution of the triazol was effected on warming the reaction mixture. The solid which separated on refluxing melted at 188° when recrystallized from heptane. Analysis indicated addition of two molecules of the isocyanate.

Analyses: Calcd. for $C_{30}H_{27}N_7O_2$: N, 18.95.

Found: N, 18.99.

SYNTHESIS OF THIURETS, KETURETS AND ALDURETS

∝-m-Tolyl-thiuret Hydroiodide, $\overline{SC(:NC_7H_7)NHC(S)}:NH.HI$. —Iodine (0.05 mol.) dissolved in alcohol was slowly added to a warm solution of m-tolyldithiobiuret (0.05 mol.) in alcohol. The reaction mixture was refluxed until the color remained constant. The white crystalline product which separated on cooling, after crystallization from hot alcohol melted at 194°. Analysis indicated the retention of one molecular proportion of alcohol of crystallization.

Analyses: Calcd. for $C_9H_{10}IN_3S_2$. C_2H_5OH: N, 10.58.

Found: N, 10.48; 10.45.

∝-p-Bromophenyl-thiuret Hydroiodide, $\overline{SC(:NC_6H_4Br)NHC(S)}$: $NH.HI$.—This product was obtained in the form of light-yellow needles melting at 237° on oxidation of p-bromophenyl-dithiobiuret with iodine. One molecule of alcohol of crystallization is retained.

Analyses: Calcd. for $C_8H_7BrIN_3S_2.C_2H_5OH$: N, 9.07.

Found: N, 9.02; 8.85.

∝, ∝′-Diphenyl-thiuret Hydroiodide, $\overline{SC(:NC_6H_5)NHC(S)}$: $NC_6H_5.HI$.—Oxidation of 1, 5-diphenyl-dithiobiuret in alcoholic

solution with iodine resulted in the formation of bright yellow platelike crystals, which when recrystallized from alcohol melted at 192°.

Analyses: Calcd. for $C_{14}H_{12}IN_3S_2$: N, 10.17.

Found: N, 10.04; 10.09.

∝ - m - Tolyldithiodi - c - methyl Keturet, $C_7H_7NHCSNCSNHC(CH_3)_2$.—Five grams of m-tolyldithiobiuret and three grams of acetone were placed in a flask and with continual shaking a strong stream of dry HCl gas was introduced. The crystalline mass liquefied and soon resolidified. The reaction product was dissolved in warm 10% sodium hydroxide and filtered, and from the cooled solution the keturet was precipitated as a white powder on acidifying with hydrochloric acid. The keturet crystallized from alcohol, in which it is only moderately soluble, in the form of white platelike crystals melting at 235-236° with darkening and decomposition.

Analyses Calcd. for $C_{12}H_{15}N_3S_2$: N, 15.86.

Found: N, 15.67; 15.77.

∝-m-Tolyl-c-phenyl-dithioalduret, $C_7H_7NHCSNCSNHCH.C_6H_5$.—Dry hydrogen chloride gas effected the condensation of benzaldehyde with the equivalent of p-tolyldithiobiuret to the alduret. This product, when purified by the method for the corresponding keturet, melted at 189°.

Analyses: Calcd. for $C_{16}H_{15}N_3S_2$: N, 13.42.

Found: N, 13.44.

∝ - (∝ - Naphthyl) - dithiodi - c - methyl Keturet, $C_{10}H_7NHCSNCSNHC(CH_3)_2$.—∝-Naphthyl-dithiobiuret condensed with acetone in the presence of dry hydrogen chloride gas. When purified and crystalized from hot alcohol, the keturet melted at 225°.

Analyses: Calcd. for $C_{16}H_{15}N_3S_2$: N, 13.42.

Found: N, 13.42.

∝-Phenyl - dithiomethyldi - c - methyl Keturet, $C_6H_5N{:}C(SCH_3)NC(SCH_3)NC(CH_3)_2$.—To a solution of ∝ - phenyl - dithiodi - c - methyl keturet (0.03 mol.) in dilute sodium hydroxide was added an excess of methyl iodide (10 g.) in alcohol solution. After several hours at room temperature a crystalline product had separated. Crystallized from hot alcohol the product melted at 134°.

Analyses: Calcd. for $C_{13}H_{17}N_3S_2$: N, 15.05.

Found: N, 14.86; 14.91.

SUMMARY

1. Methyl sulphate reacts smoothly for the conversion of monopseudodithiobiurets into dipseudodithiobiurets.

2. A method has been described for the synthesis of 1, 2, 4-triazols.

3. Several new thiurets, keturets and aldurets have been prepared.

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On the Constitution of Certain Thiazolidones. V: Phenyl, o- and p-Tolyl Derivatives

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C. O. HOLMBERG and C. C. ROBINSON

Contributions from the Chemical Laboratory of the University of Kansas

IN previous papers from this laboratory a study has been made of various aryl and acyl substituted thiazolidones. (1)

In the following series of papers we wish to put on record the results of other investigations that have been carried out in this same field.

When monophenylthiourea is treated with chloroacetic acid, chloroacetyl chloride or ethyl chloroacetate there is formed a labile thiazolidone—

A. $\overset{1}{S}\overset{2}{C}(NH)\overset{3}{N}C_6H_5\overset{4}{C}O\overset{5}{C}H_2$ which quickly rearranges to the stable form

B. $S\text{-}C(NHC_6H_5)NCOCH_2$ or the tautomeric form

C. $SC(NC_6H_5)NHCOCH_2$ (2)

Wheeler and Johnson found that the sodium salt of the stable form reacted with benzyl chloride with the formation of 2-benzyl-2-phenylamino-4-thiazolidone whose constitution was proven by its synthesis from unsymmetrical benzyl-phenylthiourea and ethyl chloroacetate.

Beckurts and Frerich (3) have stated that the monoaryl thiazolidones have the structure of the labile form A and that their sodium

(1). Walter S. Long and F. B. Dains: Trans. Kan. Acad. Sci., vol. 36 (1933). F. B. Dains and Floyd A. Eberly: J. Am. Ch. Soc. 55, 3859 (1933). John A. Davis and F. B. Dains: J. Am. Ch. Soc. 57, 2627 (1933).

(2). Wheeler and Johnson: Am. Chem. Jour. 28, 121, 146 (1902).

(3). Archiv. d. Pharm. 253, 233 (1915) C. A. 10, 888 (1916).

salts gave with ethyl iodide, the 2-ethylimino-3-aryl-4-thiazolidones, results that are in contradiction to the observations of Wheeler and Johnson and also to our own work which confirmed the stable form B as 2-arylamino (or imino-) thiazolidone as postulated by these investigations.

In addition, we have found that alkylation of the sodium salts gave mainly the 2-alkyl-arylamino thiazolidones together with yields ranging from 0 to 85% of the 2-arylimino-3-alkyl isomers; the relative yields seemed to depend upon the nature of the alkyl halide and the aryl group. Thus it was found that ethyl iodide and the sodium salt of 2-diodo phenyl thiazolidone gave 85% of the 3-ethyl derivatives and none of the 2-ethyl-2-diodo phenyl compound. (4) These results then are in absolute contradiction to the formulations of the reaction by Beckurts and Frerich who not only reversed the position of the aryl and alkyl groups but failed to isolate the isomeric thiazolidones.

EXPERIMENTAL

DERIVATIVES OF THE 2-PHENYL-THIAZOLIDONE

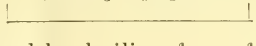
2-METHYL-2-PHENYLAMINO-THIAZOLIDONE I

$$S\text{-}C(NCH_3.C_6H_5)NCOCH_2$$

The sodium salts were readily prepared by dissolving the 2-aryl-thiazolidones in hot 5-10% sodium hydroxide solution. The salt which crystallized on cooling was filtered, washed with a little cold water and dried for use. This sodium salt was heated in methyl alcohol solution with methyl iodide in a sealed tube at 100° for eight hours. The same results are achieved by simply refluxing the components in a water bath, or by methylation with methyl sulphate. After removal of alcohol and excess methyl iodide the oily residue was dissolved in ether and the etherial solutions repeatedly extracted with 10% hydrochloric acid. Neutralization of the acid solution gave the thiazolidone I, which crystallized from alcohol in light needles melting at 125°. Its identity was proved by comparison with the same compound (5) obtained by heating molar quantities of unsymmetrical methyl-phenylthiourea, ethyl chloroacetate and pyridine (1 mol.) in alcohol solution or by the action of chloroacetyl chloride and pyridine (2 mols.) on the thiourea in cold acetone solution. The addition of pyridine prevents hydrolysis of the thiazolidone and increases the yields.

(4). John A. Davis and F. B. Dains: J. Am. Ch. Soc. 57, 2628 (1935).
(5). Dixon, J.: Ch. Soc. 71, 620 (1897).

2-METHYL-PHENYLAMINO-5-BENZAL-THIAZOLIDONE II



This was prepared by boiling for a few minutes a mixture of the thiazolidone (1-pt), benzaldehyde (1-pt), glacial acetic acid (3-pts), acetic anhydride (1-pt) and fused sodium acetate (0.5 pt). The same benzal derivative which was obtained from both preparations (methylation of I and from the unsymmetrical thiourea) was difficultly soluble in alcohol and melted at 180°. These 5-benzal compounds which are useful for the identification of the substituted thiazolidones can be synthesized also by heating the aldehyde and the thiazolidone for thirty minutes at 200-220° or more simply by adding to an alcoholic solution of the components a few drops of 10% sodium hydroxide or of piperidine. Heating the mixture is sometimes necessary.

2-PHENYLIMINO-3-METHYL-THIAZOLIDONE III

This was isolated in two percent yield from the original ether solution from which acid had extracted I. It was insoluble in dilute acid and the crystals from heptane melted at 60°.

For comparison it was synthesized from symmetrical methylphenylthiourea and ethyl chloroacetate on refluxing the alcohol solution with pyridine (1 mol.) the two preparations being identical. This is the type of compound that Beckurts and Frerich thought they had obtained but with the groups interchanged.

HYDROLYSIS

When the thiazolidone III was boiled in alcohol solution with 10% hydrochloric acid, the ring was split, yielding thioglycollic acid, methylamine, aniline and a little diphenylurea. When the methylene hydrogens at position 5 were replaced by two phenyl groups or a benzal grouping the ring was greatly stabilized. Thus 2-phenylamino-3-methyl-5-benzol-thiazolidone IV (made as was II) was dissolved in concentrated sulphuric acid and heated at 115° for fifteen minutes. After pouring the reaction mixture into ice-water, there were isolated aniline and 3-methyl-5-benzal-2-4-thiazoldione V (m. p. 135°), the formation of which proved the positions of the methyl and phenyl groups.

THE ETHYLATION OF 2-PHENYLAMINO-THIAZOLIDONE

The sodium salt and ethyl iodide gave the 2-ethyl-2-phenyl amino-thiazolidone VI (m. p. 118°). It was soluble in acid and identical with the compound obtained from unsymmetrical ethyl-phenylthiourea and ethyl chloroacetate. Each preparation gave the same 5-benzal derivative VII, melting at 165°.

The 2-phenylimino-3-ethyl-thiazolidone VIII was formed in small amounts in the above reactions, but was synthesized for comparison from symmetrical ethyl-phenylthiourea and ethyl chloroacetate. The crystals from ether melted at 74°. Its 5-benzal derivative IX melted at 100°.

The analogous n-butyl derivatives X and XI are thick oils.

ACETYL DERIVATIVES OF 2-PHENYLAMINO-THIAZOLIDONE

Wheeler and Johnson (6) on warming the "labile" phenyl thiazolidone with thioacetic acid in benzene solution obtained a compound melting at 192°, to which was given the formula 2-acetyl-imino-3-phenylthiazolidone. The same product (m. p. 192°) was obtained by us when unsymmetrical phenyl-acetyl-thiourea was treated with chloroacetyl chloride in benzene and pyridine solution. This would indicate that it was in fact 2-acetyl-2 phenylamino-thiazolidone, XII. $SC(NC_6H_5.COCH_3)NCOCH_2$, otherwise it would necessitate the rearrangement of the acetyl-phenyl thiourea to the symmetrical form and then reaction. Dixon has found, however, that the symmetrical acetyl-phenyl thiourea failed to react with chloroacetyl chloride, which tends to confirm the above formulation.

The acetyl group was readily removed on treatment with cold normal sodium hydroxide, regenerating the 2-phenylthiazolidone and it (XII) was not further acetylated on boiling with acetic anhydride.

The analogous 2-methyl-2-phenylamino-thiazolidone also failed to react with acetic anhydride showing the inertness of the substituted amino form; $R_2NC =$ of the thiazolidone.

Treatment of the 2-phenylamino-thiazolidone with chloroacetyl-chloride in pyridine and benzene solution gave negative results.

THE DIACETYL DERIVATIVE

Wheeler and Johnson had obtained a diacetyl compound XIII (m. p. 162°) on warming the 2-phenylthiazolidone with acetic an-

(6). Wheeler and Johnson, Am. Chem. Jour. 28, 143 (1902).

hydride which was confirmed by our experiments. The acetyl groups were easily removed by cold alkali or warming with dilute ammonium hydroxide.

The diacetyl compound was heated gently with amilins and from the reaction mixture were isolated acetanilide and the original phenylthiazolidone (m. p. 176°).

A possible explanation is that XIII has an acetyl group at 3 and an acetate grouping at 4, viz., $SC(NC_6H_5)NCOCH_3C\text{-}OCOCH_3CH$, which would account for the formation of acetanilide. A diacetyl derivative is only possible with a potential grouping -NH-C-OH, which is not the case with the di-substituted aminothiazolidones.

DERIVATIVES OF 2-p-TOLYL-AMINO OR IMINO-THIAZOLIDONE (m. p. 187°)

This was readily made from mono-p-tolylthiourea and chloro-acetic acid or from chloro-acet-p-toluidide on boiling with potassium thiocyanate in alcohol solution.

2-p-TOLYL-2-ETHYL-AMINO-4-THIAZOLIDONE XIV

The sodium salt was refluxed in alcohol solution with ethyl iodide for four hours. The oil remaining after steam distillation slowly solidified. Crystallized from alcohol it melted at 124°. The yield was sixty-five percent.

Hydrolysis. The compound was heated with dilute hydrochloric at 140° for four hours. The tube opened with pressure due to carbon dioxide and the solution gave a test for thioglycollic acid. It was then made alkaline, extracted with ether and the etherial solution dried with solid potassium hydroxide. Evaporation of the solvent left an oil Ethyl-p-tolylamine, which with phenylisocyanate gave α-ethyl-α-p-tolyl-β-phenylurea XV (m. p. 67°) identical with a synthetic specimen of the urea.

THE BENZAL DERIVATIVE XVI

This was formed when molar quantities of benzaldehyde and XIV were heated at 230°. It was very difficultly soluble in alcohol and melted at 179°. Heated at 140° with dilute acid, it was hydrolyzed into ethyl-p-tolylamine and 5-benzal-2, 4-thiazoldione, XVII (m. p. 242°) (7). This was confirmed by analysis and comparison with the known compound resulting from the hydrolysis of 2-imino-5-benzal-thiazolidone.

(7). Andreash, Monats. 10, 75.

2-p-TOLYLIMINO-3-ETHYL THIAZOLIDONE XVIII

This was made from ∝-ethyl-β-p-tolyl-thiourea and chloroacetic acid and was an oil. This was refluxed for twenty hours in an alcohol-hydrochloric acid solution. p-Toluidine was isolated and also a small quantity of a solid that melted at 140° after recrystallization from water and gave figures on analysis that correspond to 3-ethyl-2-4-thiazoldione XIX.

The 5-benzal-derivative from XVIII, light yellow crystals from alcohol, melted at 132°, XX. On hydrolysis it gave p-toluidine and 3-ethyl-5-benzal-2-4-thiazoldione XXI (m. p. 97°), thus confirming the structure.

BENZYL AND p-NITROBENZYL DERIVATIVES

The 2-benzyl-2-p-tolylamino-thiazolidone XXII was made from the sodium salt and benzyl chloride. It crystallized from alcohol in rhombic needles that melted at 121°. On acid hydrolysis at 140° benzyl-p-tolylamine was isolated, which with phenylisocyanate formed the known ∝-benzyl-∝-p-tolyl β-phenylurea.

2-p-NITROBENZYL-2-p-TOLYL-AMINO-THIAZOLIDONE XXIII

This crystallized from alcohol in light yellow needles melting at 142°. p-Nitrobenzyl-p-tolyl-amine XXIV (m. p. 66.7°) was one of the products of hydrolysis. This latter compound was also made for comparison from p-nitrobenzyl chloride and p-toluidine.

DERIVATIVES OF 2-o-TOLYL-AMINO-THIAZOLIDONE (m. p. 144)

This was made in the usual manner, both from mono-o-tolyl thiourea and from the chloro-acet-o-toluidide.

The sodium salt melted at 105° with loss of water, then solidified and melted again at 250°. The salt dried at 80° gave figures corresponding to equal mols. of the thiazolidone and sodium hydroxide.

Analyses for $C_{10}H_{10}N_2OS,NaOH$. Calcd: Na. 9.35; N, 11.38.

Found: Na. 9.54; N, 11.15.

2-ETHYL-2-o-TOLYLAMINO-THIAZOLIDONE XXV

This was obtained from the sodium salt and ethyl iodide as an oil which, after long standing, crystallized (m. p. 98°).

Hydrogen chloride gas precipitated a salt from a solution of the oil in dry ether (m. p. 165-8°).

Analyses for $C_{12}H_{14}N_2OS$-HCl. Calcd: HCl, 10.35.

Found: HCl, 10.21.

Its constitution was shown by its acid hydrolysis yielding ethyl-o-tolylamine, which was identified by the formation of ∝-ethyl-∝-o-

tolyl-β-phenylurea (m. p. 89°) and its identity with a known sample.

The 5-benzal-derivative melted at 193° and the isomeric 2-o-tolyl-imino-3-ethyl-thiazolidone at 74°.

Proof of the constitution of the 2-aryl-2-alkyl-amino-thiazolidones by their synthesis from the corresponding unsymmetrical thioureas was not found to be practical in several cases. The usual procedure for the preparation of such thioureas by evaporation of a water solution of their hydrogen chloride salts with ammonium thiocyanate failed to give the unsymmetrical thioureas with the following amines; viz., m-tolyl-ethyl, o-tolyl-methyl, o-tolyl-ethyl, o-tolyl-benzyl and p-tolyl-benzyl.

2-METHYL-2-o-TOLYLAMINO-THIAZOLIDONE XXVI

This was made from the sodium salt and methyl iodide. A 60% yield of the compound was obtained, which melted at 108°. From the acid hydrolysis at 140°, was isolated methyl-o-tolylamine, identified by the formation of α-methyl-α-o-tolyl-β-phenylurea (m. p. 82°).

2-o-TOLYLIMINO-3-METHYL-THIAZOLIDONE XXVII

This was formed in the usual manner from α-methyl-β-o-tolyl-thiourea and chloracetic acid. It was insoluble in dilute acid, melted at 59° and gave a 5-benzal-derivative XXVIII (m. p. 129°).

2-o-TOLYL-2-BENZYL-AMINO-THIAZOLIDONE XXIX

The sodium salt was refluxed with benzyl chloride in alcohol solution and then steam distilled; the residual oil solidified after several months standing and was then purified by recrystallization. It melted at 95° and was obtained in 40% yield. Hydrogen chloride gas precipitated a salt XXX from its ether solutions (m. p. 179°).

No.	4–THIAZOLIDONE.	Formula.	M.p. °C.	Percent nitrogen.	
				Calcd.	Found.
I	2-methyl-2-phenyl	$C_{10}H_{10}N_2OS$	126	13.59	13.58
II	2-methyl-2-phenyl amino-5-benzal	$C_{17}H_{14}N_2OS$	180	9.53	9.30
III	2-phenylimino-3-methyl	$C_{10}H_{10}N_2OS$	60	13.59	13.50
IV	2-phenylimino-3-methyl-5-benzal	$C_{17}H_{14}N_2OS$	135	9.53	9.55
V	3-methyl-5-benzal-2-4 thiazolidone	$C_{11}H_9NO_2S$	135	6.39	6.79
VI	2-ethyl-2-phenyl-amino	$C_{11}H_{12}N_2OS$	118	12.73	12.51
VII	2-ethyl-2-phenyl amino-5-benzal	$C_{18}H_{16}N_2OS$	165	9.09	9.18
VIII	2-phenylimino-3-ethyl	$C_{11}H_{12}N_2OS$	74	12.73	12.67
IX	2-phenylimino-3-ethyl-5-benzal	$C_{18}H_{16}N_2OS$	100	9.09	8.81
X	2-n-Butyl-2-phenylamino	$C_{13}H_{16}N_2OS$	oil	11.29	11.29
XI	2-phenylimino-3-n-butyl	$C_{13}H_{16}N_2S$	oil	11.29	11.28
XII	2-phenyl-2-acetylamino	$C_{11}H_{10}N_2O_2S$	192	11.97	11.95
XIII	Diacetyl-2-phenyl	$C_{13}H_{12}N_2O_3S$	162	10.14	10.50
XIV	2-ethyl-2-p-tolylamino	$C_{12}H_{19}N_2OS$	124	11.97	11.92
XV	α-ethyl-α-p-tolyl β-phenylurea	$C_{16}H_{18}N_2O$	67	11.02	10.99
XVI	2-ethyl-2-p-tolyl-5-benzal	$C_{19}H_{18}ON_2S$	179	8.70	8.74
XVII	5-benzal-2-4-thiazoldione	$C_{10}H_7NO_2S$	242	6.83	6.78
XVIII	2-p-tolylimino-3-ethyl	$C_{12}H_{14}N_2OS$	oil	11.97	12.04
XIX	3-ethyl-2-4-thiazoldione	$C_5H_7NO_2S$	140	9.65	9.64

No.	4–THIAZOLIDONE.	Formula.	M.p.°C.	Percent nitrogen.	
				Calcd.	Found.
XX	2-p-tolylimino-3-ethyl-5-benzal	$C_{19}H_{18}N_2OS$	132	8.70	8.65
XXI	3-ethyl-5-benzal 2-4-thiazoldione	$C_{12}H_{11}N_2OS$	97	6.01	6.10
XXII	2-benzyl-2-p-tolylamino	$C_{17}H_{16}N_2OS$	121	9.46	9.47
XXIII	2-p-nitrobenzyl-2-p-tolylamino	$C_{17}H_{15}N_3O_3S$	142	12.32	12.40
XXIV	p-nitrobenzyl-p-tolylamine	$C_{14}H_{14}N_2O_2$	67	11.57	11.52
XXV	2-ethyl-2-o tolylamino	$C_{12}H_{14}N_2OS$	98	11.97	11.66
XXVI	2-methyl-2-o-tolylamino	$C_{11}H_{12}N_2OS$	108	12.72	12.75
XXVII	2-o-tolylimino-3-methyl	$C_{11}H_{12}N_2OS$	59	12.72	12.82
XXVIII	2-o-tolylimino-3-methyl-5-benzal	$C_{18}H_{16}N_2OS$	129	9.09	8.83
XXIX	2-benzyl-2-o-tolylamino	$C_{17}H_{16}N_2OS$	95	9.46	9.58
XXX	2-benzyl-2-o-tolylamino hydrochloride	$C_{17}H_{17}ClN_2OS$	179	8.42	8.21

SUMMARY

The aryl thiazolidones were readily prepared by the action of chloroacetic acid, chloroacetic ester or chloroacetyl chloride on the mono-aryl thioureas or by boiling the chloriacet aryl amide with potassium thiocyanate.

Beckurts and Frerich had formulated these compounds as 2-imino-3-aryl-thiazolidones, but the work of Wheeler and Johnson and the investigations in this laboratory have proved that they are really 2-aryl amino or imino thiazolidones.

In this paper (using derivatives of aniline and o and p-toluidine) it has been shown that the alkylation of the sodium salts gave mainly the 2-alkyl-2-aryl-amino thiazolidones (A) soluble in dilute acid and a small amount of the isomeric 2-aryl imino 3-alkyl compound (B) insoluble in dilute acid. The constitution of type A was proved by synthesis from the unsymmetrical alkyl-aryl thioureas and by hydrolysis of the benzal derivative, which gave 5-benzal-2, 4-thiazolidone and secondary aryl-alkylamine.

The structure of type B was shown by synthesis from the symmetrical alkyl-aryl thioureas and the hydrolysis of the 5-benzal compound into a primary aryl amine and 3-alkyl-5-benzal-2, 4-thiazolidone.

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On the Reactions of the Thiazolidones. VI: Some Derivatives of m-Toluidine

F. B. DAINS, ROBERT D. COGHILL and SAMUEL S. TIHEN
Contribution from the Chemical Laboratory of the University of Kansas

SOME years ago Beckurts and Frerich (1) investigated the action of potassium thiocyanate on chloroacet-m-toluidide.

Interpreting their results in the light of the work of Wheeler and Johnson (2), they obtained (a) the thiocyanate (m. p. 97°), (b) the "labile" form, *i. e.*, the 2-imino-3-m-tolylthiazolidone (m. p. 136°), and (c) the stable 2-m-tolylamino-thiazolidone (m. p. 161°). To this latter (m. p. 161°), Beckurts and Frerich gave the 2-imino-3-m-tolyl structure, basing their formula on the fact that on boiling the compound with 25% hydrochloric acid, 3-m-tolyl-2-4-thiazoldione was produced.

This does not of necessity prove the contention, since it has been found that the thiazolidone ring with an unsubstituted methylene grouping may open and close again after the loss of either ammonia or the aryl amine.

Our own experiments confirmed the formulation of Wheeler and Johnson and proved definitely that the tolyl group was at position 2 and not 3. We found that the thiazolidone which was made both from mono-m-tolylthiourea and from chloroacet-m-toluidide was decidedly stable. Heating with various amounts of acid either gave no results or only m-toluidine. In no case were we able to isolate the 3-m-tolyl-thiazoldione (m. p. 90°).

EXPERIMENTAL

Sodium Salt.

This was made by heating the thiazolidone with 10% sodium hydroxide and filtering. From the cold solution the salt crystallized

(1). Archiv. d. Pharm. 253. 233-65 (1915).
(2). Wheeler and Johnson: Am. Chem. J. 28, 121-146 (1902).

out in good yield. This was filtered off at the pump, washed with a little cold water and dried for use.

2-ETHYL-2-m-TOLYLAMINO-THIAZOLIDONE I

The sodium salt was refluxed in alcohol solution with ethyl iodide for several hours and then the alcohol and excess ethyl iodide removed by steam distillation. The oily residue was taken up in ether and the ether solution repeatedly extracted with 10% hydrochloric acid. From the acid solution after neutralization with sodium carbonate was precipitated I, which, crystallized from heptane, melted at 106°.

Beckurts and Frerich synthesized this compound (m. p. 106°) by a similar procedure, but had given to it the erroneous structure, 2-ethylimino-3-tolyl-thiazolidone, based evidently on their idea that the original thiazolidone was a 2-imino-3-tolyl compound.

EVIDENCE FOR THE AMINO STRUCTURE FOR I

Molar quantities of the thiazolidone I and benzaldehyde were dissolved in hot alcohol with the addition of a few drops of piperidine. From the solution there slowly crystallized the 2-ethyl-2-m-tolylamino-5-benzal-thiazolidone II (m. p. 185° from heptane).

Hydrolysis. On long heating at 125° in 50% sulphuric acid. I was hydrolyzed into 5-benzal-2-4-thiazoldione (m. p. 243°) and ethyl-m-tolylamine. No evidence of m-toluidine was found. These results showed that the ethyl and tolyl groups are joined to a nitrogen at position 2.

2-m-TOLYLIMINO-3-ETHYL-THIAZOLIDONE III

The ether solution from which I had been extracted contained a small amount of an acid insoluble oil which failed to crystallize after months' standing. When its alcohol solution was treated with benzaldehyde and piperidine, there was obtained the same benzal-derivative IV (m. p. 127°) that was made from a synthetic specimen of III.

α-Ethyl-β-m-tolylthiourea from m-tolylisothiocyanate and ethylamine, was heated in alcohol solution with ethyl chloroacetate and pyridine. From the reaction mixture was isolated III in 80% yield. The crystals from ether melted at 57°. This condensed with benzaldehyde yielding the benzal-compound IV (m. p. 127°). Both specimens were identical as shown by a mixed melting point and analysis; thus proving that the 2-3-isomer was formed in small amount in the original reaction.

HYDROLYSIS PRODUCTS OF III

This was refluxed for twenty hours in an alcohol solution containing 3.5% hydrochloric acid. After evaporating off most of the solvent, the solution was made slightly alkaline and distilled with steam which carried over m-toluidine. The residual solution was concentrated and a solid crystallized out, containing no sulphur and melting at 110°. Analysis showed 24.35% and 24.40% nitrogen. Diethylurea melts at 109-10° and contains 24.15% nitrogen. There was no lowering of the melting point when mixed with a specimen of diethylurea made by disulphurizing diethylthiourea with yellow mercuric oxide. The diethylurea must be due to the intermediate formation of 3-ethyl-2-4-thiazoldione, described in the previous paper and then further hydrolysis into thioglycollic acid and ethyl carbonic acid and then diethylurea.

Definite proof of the structure of III was afforded in the hydrolysis of the benzal-compound IV. Heating with 50% sulfuric acid gave m-toluidine and 3-ethyl-5-benzal-2, 4-thiazoldione V (m. p. 97°).

2-METHYL-2-m-TOLYLAMINO-4-THIAZOLIDONE VI

This was the acid soluble product when the sodium salt was methylated. The crystals from heptane melted at 104°. With the aid of piperidine it condensed with benzaldehyde giving the 5-benzal-derivatives VII (m. p. 173°).

Heating with 50% sulfuric acid broke the ring of VII and there was isolated from the reaction product after making alkaline and distilling with steam, methyl-m-tolylamine. This was identified by its reaction product with phenylisocyanate, viz.: α-methyl-α-m-tolyl-β-phenylurea (m. p. 76°). Anal. Calcd. for $C_{15}H_{16}N_2O$;N, 11.67. Found: 11.90.

2-m-TOLYLIMINO-3-METHYL THIAZOLIDONE VIII

This was present in the original ether extract from which the acid soluble VI had been extracted. It failed to crystallize, but its presence was proved by the formation of a benzal-derivative IX (m. p. 167°).

α-methyl-β-m-tolylthiourea from methyl amine and m-tolyl isothiocyanate melted at 105°. N. Calcd. 15.53. Found: 15.65. This with ethyl chloroacetate gave a 70% yield of the 2-m-tolylimino-3-methyl-thiazolidone VIII. Crystals from ether, melting at 65°. The benzal-derivative from this melted at 167° and was identical with the one above (IX).

Its constitution was proved and in consequence that of VIII, by its hydrolysis into m-toluidine and the known 3-methyl-5-benzal 2, 4-thiazoldione X. (m. p. 133°).

DERIVATIVES OF TRIBROMO-m-TOLUIDINE (1-AMINO-3-METHYL-2, 4, 6-TRIBROMO-BENZENE)

A satisfactory method for its preparation was to add to a dilute solution of m-toluidine hydrochloride. With constant stirring the calculated amount of bromine dissolved in acetic acid. It melted at 101°. Calcd. N, 4.07. Found: 3.82.

CHLOROACET-TRIBROMO-m-TOLUIDIDE XI

This was prepared in 70% yield by heating on a water bath a mixture of tribromo-m-toluidine moistened with alcohol and an excess of chloroacetyl chloride in a flask fitted with an air condenser. It was purified by recrystallization from benzene and then melted at 196°.

When this was boiled in alcohol solution with potassium thiocyanate it gave a product which could not be purified completely. However, the sodium salt of the tribromo-tolyl-thiazolidone was obtained by treating the above product with 10% sodium hydroxide and filtering the hot solution. The sodium salt crystallized out on cooling. When this was treated with methyl iodide in the usual manner, a methyl derivative XII insoluble in dilute acid was obtained. It melted at 143° after repeated crystallizations from benzene.

Lack of time prevented a more accurate determination of its constitution, but it is doubtless the 2-(tribromo-m-tolyl)imino-3-methyl thiazolidone. This is based upon its insolubility in dilute acid and its analogy to the behavior of 2, 4-diiodophenyl-thiazolidone, which gave an 85% yield of the 2-aryl-3-alkyl-thiazolidone and none of the 2-2 isomer. (3)

For the sake of record, the following data are included in this paper. The results are incomplete owing to the departure of the junior authors from the University.

α-n-Amyl-β-o-Tolylthiourea XIII from amylamine and o-tolyl isothiocyanate, melted at 70°. The thiazolidone from this thiourea was an oil, but the 2-o-tolylimino-3-amyl-5-benzal thiazolidone XIV melted at 80°.

α-n-Amyl-β-m-tolylthiourea XV. This was made from m-anyl amine and m-tolyl isothiocyanate and when crystallized from ether,

(3). John A. Davis and F. B. Dains: Jour. Am. Ch. Soc. 57, 2628 (1935).

melted at 46°. The thiazolidone was also an oil, but its benzal derivative XVI melted at 68°. Only m-toluidine was isolated from its hydrolysis products.

The above structure is assigned from analogy in the behavior of symmetrical n-amyl-phenyl thiourea. (4)

(4). John A. Davis and F. B. Dains: Jour. Am. Chem. Soc. 57, 2629 (1935).

No.	Compound.	Formula.	M.p.°C.	Percent nitrogen.	
				Calcd.	Found.
I	2-Ethyl-2-m-tolyl-amino-thiazolidone	$C_{12}H_{14}N_2OS$	106	11.97	12.00
II	2-Ethyl-2-m-tolyl-amino-5-benzal-thiazolidone	$C_{19}H_{18}N_2OS$	185	8.70	8.76
III	2-m-Tolylimino-3-ethyl-thiazolidone	$C_{12}H_{14}N_2OS$	57	11.97	11.90
IV	2-m-tolylimino-3-ethyl-5-benzal-thiazolidone	$C_{19}H_{18}N_2OS$	127	8.70	8.60
V	3-ethyl-5-benzal 2, 4-thiazoldione	$C_{12}H_{11}NO_2S$	97	6.01	5.85
VI	2-methyl-2-m-tolyl-amino thiazolidone	$C_{11}H_{12}N_2OS$	104	12.73	12.85
VII	2-methyl-2-m-tolyl-amino-5-benzal-thiazolidone	$C_{18}H_{16}N_2OS$	173	9.10	8.99
VIII	2-m-tolyl-imino-3-methyl-thiazolidone	$C_{11}H_{12}N_2OS$	65	12.73	12.78
IX	2-m-tolylimino-3-methyl-5-benzal-thiazolidone	$C_{18}H_{16}N_2OS$	167	9.10	9.14
X	3-methyl-5-benzal-2, 4-thiazoldione	$C_{11}H_9NO_2S$	133	6.39	6.40
XI	Chloro-acet-tribromo-m-toluidide	$C_9H_7Br_3ClNO$	196	3.33	3.21
XII	2-tribromo-m-tolyl-imino-3-methyl-thiazolidone	$C_{11}H_9Br_3N_2OS$	143	6.12	5.87
XIII	α-n-Amyl-β-o-tolyl thiourea	$C_{13}H_{20}N_2S$	70	11.87	11.96
XIV	2-o-Tolyl-imino-3-n-amyl-5-benzal-thiazolidone	$C_{22}H_{24}N_2OS$	80	7.69	7.62
XV	α-n-amyl-β-m-tolyl-thiourea	$C_{13}H_{20}N_2OS$	46	11.87	11.98
XVI	2-m-tolyl-imino-3-n-amyl-5-benzal-thiazolidone	$C_{22}H_{24}N_2OS$	68	7.69	7.77

SUMMARY

This is a study of the constitution and reactions of 2-m-tolyl-amino-4-thiazolidone. Beckurts and Frerich had stated that this was a 2-imino-3-m-tolyl-thiazolidone which our results have shown to be incorrect.

In addition ethylation of the sodium salt gave both isomers. (A), the 2-ethyl-2-m-tolyl-thiazolidone, was the main product. Its benzal derivative was hydrolyzed into 5-benzal-2, 4-thiazoldione and ethyl-m-tolylamine. (B), the 2-m-tolyl-imino-3-ethyl-thiazolidone, was identified by means of its 5-benzal-compound which on hydrolysis gave m-toluidine and 3-ethyl-5-benzal-thiazoldione.

The methylation products of the sodium salt afforded corresponding results. The sodium salt of tribromo-m-tolyl thiazolidone gave almost entirely the 2-alkyl-3-aryl thiazolidone, thus showing the effect of the heavy tribromo radical.

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On the Reactions of the Thiazolidones. VII: Some Derivatives of 1-Amino-2-methyl-5-nitro benzene

F. B. DAINS and PAULINE GARBER

Contribution from the Chemical Laboratory of the University of Kansas

TWO thiazolidones, derived from amines in which the amino and nitro groups are meta to each other, viz., m-nitroaniline and 1-amino-3-nitro-4-methyl-benzene have been investigated by Beckurts and Frerich (1) and Walter S. Long and F. B. Dains (2). In each of these cases, on alkylation of the sodium salt only the 2-aryl-2-alkyl-amino-thiazolidones were isolated and none of the 2-aryl-imino-3-alkyl isomers.

In order to study the effect of the meta position, there has been chosen a derivative of o-toluidine in which the nitro group is meta to the amino and para to the methyl. Our results which are set forth in the following paper show that both isomers are formed on alkylation of the thiazolidone and that there is no inherent hindrance in such a meta position.

EXPERIMENTAL

The chloro-acet-nitro toluidide used was easily made as follows: A mixture of the nitro-toluidine (1 mol.) and pyridine (1⅕ mols.) was dissolved in acetone in a flask cooled with ice water. Chloro-acetyl chloride (1 mol.) was added slowly. After standing for several hours, the contents of the flask were poured into water and the precipitate filtered, washed and dried.

(1). Beckurts and Frerich, Archiv. d. Pharm. 253, 233-65 (1915).
(2). Walter S. Long and F. B. Dains: Trans. Kan. Acad. Sci. Vol. 16, 119-24 (1933).

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2(5-NITRO-2-METHYL-PHENYL)-AMINO-4-THIAZOLIDONE I

Molar quantities of the chloro-acet-compound and potassium thiocyanate were boiled in alcohol solution for twenty hours—no effort being made to isolate any intermediate products. Water precipitated a crude mass which was purified by crystallization from glacial acetic acid. The brownish crystals melted at 186°.

Analyses: Calcd. for $C_{10}H_9N_3O_3$: N, 16.74.

Found: 16.25.

The ring was completely disrupted when I was heated with 50% sulfuric acid at 150° with the formation of ammonia and the nitrotoluidine (m. p. 110°). In the reaction flask a small amount of nitrotoluidine sulfate had crystallized out. It melted at 203° and contained 11.02% nitrogen (calcd. 11.2%). A preparation of the pure sulfate melted at 213-16°.

2(5-NITRO-2-METHYL PHENYL)-2-ETHYL-AMINO-4-THIAZOLIDONE II

The sodium salt which was made by the action of hot 10% sodium hydroxide on I, was heated with ethyl iodide in alcohol solution for eight hours and then the excess ethyl iodide and alcohol removed by steam distillation. The gummy residue was dissolved in ether and the solution extracted several times with dilute hydrochloric acid.

Neutralization of the acid solution gave a solid which was purified by recrystallization from heptane. The blunt yellow crystals melted at 85-7°.

Analyses: Calcd. for $C_{12}H_{13}O_3N_3S$: N, 15.06.

Found: 15.13.

When the compound was hydrolyzed and the solution made alkaline, ammonia was set free and a precipitate formed which purified from alcohol formed yellow crystals melting at 81-2°.

Analyses: Calcd. for $C_9H_{12}N_2O_2$: N, 15.56.

Found: 15:86.

This was *(5-nitro-2-methyl-phenyl)-ethyl amine III,* which W. MacCullum has reported (3) as melting at 81-2°. The formation of ammonia and the secondary amine thus proved the constitution of II. All efforts to condense the thiazolidone with benzaldehyde were unsuccessful.

(3). W. MacCallum, J. Ch. Soc. 67.247 (1895).

2-(5-NITRO-2-METHYL PHENYL)-IMINO-3-ETHYL-4-THIAZOLIDONE IV

The ether residue from which II had been extracted was purified by crystallization from heptane. The yellow crystals, insoluble in dilute acid, melted at 124-5° and it is interesting to note that five times as much of the imino isomer IV was isolated as of the amino form II.

Analyses: Calcd. $C_{12}H_{13}N_3O_3S$: N, 15.06.

Found: 15.29.

On hydrolysis it gave the original nitrotoluidine (110°) and a volatile amine characterized by the carbylamine reaction, thus proving that the aryl and alkyl groups were joined to different nitrogens.

Molar quantities of this thiazolidone and benzaldehyde in hot alcohol solution condensed immediately on the addition of a few drops of dilute sodium hydroxide. The *2-nitrotolyl-imino-3-ethyl-5-benzal-thiazolidone* V melted at 140°.

Analyses: Calcd. for $C_{19}H_{17}N_3O_3S$: N, 11.44.

Found: 11.10.

The position of the two groups was indicated by the hydrolysis products: viz., the original nitrotoluidine and the known 3-ethyl-5-benzal-2, 4-thiazoldione (4) (m. p. 95°) VI.

Analyses: Calcd. for $C_{12}H_{11}NO_2S$: N, 6.00.

Found: 6.27.

2-(5-NITRO-2-METHYL-PHENYL) 2-METHYL-AMINO-4-THIAZOLIDONE VII

Methylation of the sodium salt gave a black tarry residue which was taken up in ether. The acid extract on neutralization precipitated a product which crystallized from heptane in long reddish-orange needles, melting at 101°.

Analyses: Calcd. for $C_{11}H_{11}N_3O_3S$: N, 15.85.

Found: 15.75.

Like its analogue II, this also failed to condense with benzaldehyde.

From the hydrolysis reaction-mixture was isolated ammonia (but no alkyl amine) and the 5-nitrotolyl-methylamine VIII orange

(4). F. B. Dains and Floyd A. Eberly: J. Am. Ch. Soc. 50. 3861 (1933).

crystals from alcohol (m. p. 109-10°) (5). The melting point in literature was recorded as 107.5°.

Analyses: Calcd. for $C_8H_{10}N_2O_2$: N, 16.88.

Found: 17.07.

2-(5-NITRO-2-METHYL-PHENYL)-IMINO-3-METHYL-4-THIAZOLIDONE IX

This was isolated in somewhat larger amount than VII from the original methylation product, since it was insoluble in dilute acid. The needles from heptane melted at 134.5°.

Analyses: Calcd. for $C_{11}H_{11}N_3O_3S$: N, 15.85.

Found: 15.72.

It was broken down by heating with acid into methylamine and the nitrotoluidine (m. p. 110°). Its *5-benzal derivative, X,* which was readily formed, melted at 188°.

Analyses: Calcd. for $C_{18}H_{15}N_3O_3S$: N, 11.90.

Found: 11.68.

Incomplete experiments with benzyl chloride and the sodium salt indicated the formation of the two possible benzyl isomers. The 2-nitrotolyl-2-benzyl amino-thiazolidone melted at 160° and on hydrolysis gave the 2-nitrotolyl-benzyl amine (m. p. 124°) (6).

SUMMARY

Two derivatives of aryl thiazolidones, previously investigated, in which a nitro group was meta to the amino grouping, had failed to give the 2-arylimino-3-alkyl isomers. For this reason a study of the thiazolidone from 1-amino-2-methyl-5-nitrobenzene was undertaken in order to ascertain whether there was any special hindrance in such a meta position. Our work has proved that the original compound has the structure 2-(5-nitro-2-methyl-phenyl) amino-4-thiazolidone and that the sodium salt on ethylation gave both the 2-nitrotolyl-2-ethyl (A) and in larger amount, showing the effect of the less basic grouping, the 2-nitrotolyl-imino-3-ethyl thiazolidone (B). Their constitution was shown by their hydrolysis product; A yielding ammonia and a secondary amin; B, an alkylamine and nitrotoluidine. It was noted that the 2-2-isomers failed to condense with benzaldehyde, while the 2-3 isomers easily formed benzal derivatives.

(5). Gnehm and Plumer, Ann. 304, 99.

(6). Ber. 35, 338 (1902).

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On the Reactions of the Thiazolidones. VIII: Some Derivatives of 2-Amino-5-nitro-toluene and 2-Amino-3-bromo-5-nitro-toluene

F. B. DAINS and CLARENCE E. GROTHAUS

IN the previous papers (1) it has been shown that the alkylation of the sodium salts of the 2-aryl-imino- or amino-thiazolidones gave usually a mixture of the 2-alkyl-2-aryl-amino- and the 3 - alkyl-2-arylimino-thiazolidones, $S\text{-}C(NRR')N\text{-}COCH_2$ and $SC(NR)NR'COCH_2$, the amount of each varying with nature of the aryl group.

The results of our investigations show the inaccuracy of the interpretation of Beckurts and Frerich, that the alkylation of the sodium salts gave a 2-alkyl-imino-3-aryl-thiazolidone. They also confirm the work of Long (loc. cit.) and point out that the substitution of nitro, and bromo and nitro groups in the aryl nucleus increases the amount of the 3-alkyl isomers.

EXPERIMENTAL

PREPARATION OF 2-(4-NITRO-2-METHYL-PHENYLAMINO)-4-THIAZOLIDONE (I),

$$\overset{1}{S}\overset{2}{C}(NC_6H_3CH_3NO_2)\overset{3}{N}\overset{4}{C}O\overset{5}{C}H_2$$

This compound was made by refluxing the chloracetyl derivative of 2-amino-5-nitro-toluene and an equivalent amount of potassium thiocyanate together in dilute alcohol solution. The thiazolidone melted at 172°. Beckurts and Frerich and Walter S. Long prepared

(1). Beckurts and Frerich, Archiv. d. Pharm. *353*, 233-65 (1915).
Wheeler and Johnson, Am. Ch. J. *28*, 121-35 (1902).
Walter S. Long and F. B. Dains, Trans. Kan. Acad. Sci. *36*, 119-24 (1933).
F. B. Dains and Floyd A. Eberly, J. A. C. S. *55*, 3859 (1933).
John A. Davis and F. B. Dains, J. A. C. S. *57*, 2627 (1935).

this same compound similarly. Its preparation is described in this connection as it was used in this investigation as a starting material in the synthesis of several other derivatives.

The sodium salt of this derivative was easily prepared by adding the thiazolidone to a hot 10% sodium hydroxide solution. On cooling, the sodium salt crystallized out.

HYDROLYSIS OF 2-(4-NITRO-2-METHYL-PHENYLAMINO) -4-THIAZOLIDONE

Five grams of the thiazolidone were heated with 50% sulfuric acid at 150° for three hours. When poured into water and neutralized with sodium hydroxide, a yellow precipitate was isolated which melted at 126-127° after crystallization from alcohol. A mixed melting point proved this to be 2-amino-5-nitro-toluene. The alkaline solution was found to contain ammonia, formed evidently by breaking down of the heterocyclic ring.

2-(4-NITRO-2-METHYL-PHENYLAMINO)-5-BENZAL-4-THIAZOLIDONE (II),

$$SC(NC_7H_6NO_2)NCOC=CHC_6H_5$$

This derivative was prepared by treating the thiazolidone (5 grams) with benzaldehyde (4 c.c.) in alcoholic solution, to which a few drops of sodium hydroxide had been added. After standing several days the product precipitated out. Recrystallization from benzene yielded crystals melting at 230°.

In attempting to hydrolyze the compound, no results were obtained using alcoholic sodium hydroxide. With 50% sulfuric acid, the derivative yielded 2-amino-5-nitro-toluene and an unidentified tarry residue.

2-(4-NITRO-2-METHYL-PHENYL)-2-METHYL-AMINO-4-THIAZOLIDONE (III),

$$SC(NCH_3.C_7H_6NO_2)=NCOCH_2$$

Twenty grams of the sodium salt of 2-(4-nitro-2-methyl-phenyl-amino-4-thiazolidone) were refluxed with methyl iodide for eight hours in alcoholic solution. The addition of water precipitated the product as a tarry mass which solidified to a grainy precipitate on standing. On extracting with 10% hydrochloric acid, about one half to two thirds of the product dissolved, reprecipitating on addition of ammonia. When crystallized from heptane, fine lemon yellow needles melting at 158° were formed. The structure was proved by

hydrolysis of the compound. The residue was shown to be 2-(4-nitro-2-methyl-phenylamino)-3-methyl-4-thiazolidone (see description).

HYDROLYSIS OF 2-(4-NITRO-2-METHYL-PHENYL)-2-METHYL-AMINO-4-THIAZOLIDONE

This was effected by heating to 150° for six hours in 50% sulfuric acid, the reaction product going into solution. On addition of sodium hydroxide, a yellow precipitate formed which melted at 137° when crystallized from alcohol. By a mixed melting point this was shown to be 4-nitro-2-methyl-phenyl methyl amine.

The alkaline solution was distilled, a volatile base being carried over which was collected in hydrochloric acid and when analyzed proved to be ammonia. Since a secondary amine and ammonia were obtained, the structure of the compound is shown to be that assumed. If the methyl group were attached to a different nitrogen than the aryl group, methyl amine should have been obtained on hydrolysis instead of ammonia.

2-(4-NITRO-2-METHYL-PHENYL)-2-METHYL-AMINO-5-BENZAL-4-THIAZOLIDONE (IV), $SC(NCH_3C_7H_6NO_2)NCOC=CHC_6H_5$

This was prepared by refluxing 2-(4-nitro-2-methyl-phenyl)-2-methyl-amino-4-thiazolidone with benzaldehyde in a solution of acetic acid and acetic anhydride. When crystallized from acetic acid or benzene, it melted at 238-240°.

Attempts to hydrolyze in acid and alkali failed except that small quantities of 5-nitro-2-methylamino-toluene were isolated.

2-(4-NITRO-2-METHYL-PHENYLIMINO)-3-METHYL-4-THIAZOLIDONE (V), $SC(NC_7H_6NO_2)NCH_3COCH_2$

The portion of the product from the methylation of 2-(4-nitro-2-methyl-phenylamino)-4-thiazolidone, which was insoluble in hydrochloric acid proved to be this compound. When crystallized from heptane, fine lemon colored crystals melting at 93° were obtained.

Hydrolysis of the Derivative: This compound was hydrolyzed in the same manner as its isomer. 2-Amino-5-nitro-toluene was identified as one of the products. The acid solution from hydrolysis was made strongly alkaline with sodium hydroxide and distilled. The

distillate yielded methyl amine which was proved by the isonitrile test and analysis. These results indicated that the methyl group was in the three position on the heterocyclic ring.

2-(4-NITRO-2-METHYL-PHENYLIMINO)-3-METHYL-5-BENZAL-4-THIAZOLIDONE (VI)

This was prepared by treating 2-(4-nitro-2-methyl-phenylimino)-3-methyl-4-thiazolidone with benzaldehyde in the manner previously described. The small yellow crystals melted at 197°.

2-(4-NITRO-2-METHYL-PHENYL)-2-ETHYLAMINO-4-THIAZOLIDONE (VII)

Our ethylation of the sodium salt of the nitrotolyl thiazolidone confirmed the work of Long, who obtained the 2- and 3-ethyl derivatives and proved their structure. Beckurts and Frerich (loc. cit.) had isolated the 2-nitrotolyl-2-ethyl-thiazolidone (m. p. 129°) but had assigned it to the erroneous structure 2-ethylimino-3-(p) nitrotolyl-4-thiazolidone.

When this derivative was hydrolyzed with 50% sulfuric acid, 5-nitro-2-ethylamino-toluene melting at 98° was isolated and identified.

2-(4-NITRO-2-METHYL-PHENYLIMINO)-3-ETHYL-4-THIAZOLIDONE (VIII)

In the ethylation just described, the portion of the product which was insoluble in 10% hydrochloric acid was purified and found to melt at 86°.

When hydrolyzed by heating with 50% sulfuric, 2-amino-5-nitrotoluene and ethyl amine were isolated and identified. These results indicate the compound to have the structure assumed.

2-(4-NITRO-2-METHYL-PHENYLIMINO)-3-BENZYL-4-THIAZOLIDONE (IX)

This compound was obtained by refluxing the sodium salt of the monosubstituted thiazolidone with benzyl chloride (excess) in alcoholic solution for eight hours. The excess benzyl chloride was removed by steam distillation. None of the product dissolved in 10% hydrochloric acid and no evidence of the 2-benzyl isomer was obtained. It separates as small yellow needles melting at 98° when crystallized from a mixture of chloroform and ether.

Hydrolysis: To effect hydrolysis, it was necessary to employ a 75% solution of sulfuric acid. The mixture was heated for six hours at 150°. From this solution was identified by means of a mixed

melting point, 5-nitro-2-amino-toluene. A volatile amine was isolated from the solution which gave a positive isonitrile test and yielded a benzoyl derivative which melted at 102°. This benzoyl derivative of benzyl amine is recorded in the literature (2). These results substantiate the assumption that the benzyl group is attached to the nitrogen of the heterocyclic ring.

2-AMINO-3-BROMO-5-NITRO-TOLUENE

Since this product was used at the starting material for a series of compounds, it was made in considerable quantities. This was effected by suspending the nitro toluidine in water and slowly adding bromine with constant stirring. When crystallized from alcohol, it formed dark gold prisms, melting at 180°. This compound is reported in the literature (3).

CHLORO-ACETYL DERIVATIVE OF 2-AMINO-3-BROMO-5-NITRO-TOLUENE (X)

Preparation of this compound was attempted by treating the toluidine with chloracetyl chloride in acetone and pyridine. When this failed, dry benzene was used instead of acetone without results. Finally the amine was heated directly with a large excess of chloroacetyl chloride and the mixture heated to fuming at intervals. The mass was allowed to stand several days and then washed with water. It crystallized from alcohol in white crystals which melted at 202°.

2-(4-NITRO-6-BROMO-2-METHYL-PHENYLAMINO)-4-THIAZOLIDONE (XI)

2-Methyl-4-nitro-6-bromo-chloracetanilide (50 grams) was treated with potassium thiocyanate (18 grams) in the usual manner, yielding the thiazolidone which melted at 223° when crystallized from alcohol.

Hydrolysis: This was brought about by heating with 50% sulfuric acid. From the solution was isolated 2-amino-3-bromo-5-nitro-toluene. Ammonia was also found to be a product of hydrolysis.

2-(6-BROMO-4-NITRO-2-METHYL-PHENYLIMINO)-3-METHYL-4-THIAZOLIDONE (XII)

The sodium salt of the thiazolidone (XI) was treated with methyl iodide in the regular manner. The major part of the product was insoluble in dilute acid. It separated from benzene as light cream colored crystals, melting at 204°.

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(2). Blacher, Ber. 28, 424.
(3). Ber. 13, 964 (1880).

Hydrolysis: This was effected by heating a small portion of the compound in a sealed tube with 25 c. c. of 10% hydrochloric acid at 140° for eight hours. The hydrolysis yielded only one product, a volatile amine which could be identified. A good isonitrile test and its analysis proved it to be methyl amine. This substantiated the structure assumed as it is not probable that methyl amine would be obtained if the methyl group were attached to the other nitrogen.

2-(6-BROMO-4-NITRO-2-METHYL-PHENYLAMINO)-5-BENZAL -4-THIAZOLIDONE (XIII)

The thiazolidone (XI) was heated with benzaldehyde in a solution of acetic acid and acetic anhydride and then allowed to stand for several days. It came down from acetic acid solution as fine fluffy white crystals which had not melted at 250°.

2-(6-BROMO-4-NITRO-2-METHYL-PHENYLIMINO)-3-ETHYL -4-THIAZOLIDONE (XIV)

This derivative was made by refluxing the sodium salt of the thiazolidone (XI) with ethyl iodide. The product was found to be insoluble in dilute acid. The purified product from benzene melted at 164°. None of the 2-ethyl derivative was formed.

Hydrolysis: This was effected in the same manner as the corresponding methyl derivative. Ethyl amine was identified from the hydrolysis by the isonitrile test and analysis as the hydrochloride salt.

2-(6-BROMO-4-NITRO-2-METHYL-PHENYLIMINO)-3-BENZYL -4-THIAZOLIDONE (XV)

In this case the sodium salt of the thiazolidone (XI) was allowed to react with benzyl chloride. The compound was found to be insoluble even in concentrated hydrochloric acid. It was crystallized from a mixture of benzene and heptane and melted at 172°.

Hydrolysis: This hydrolysis was also carried out with 10% hydrochloric acid in a sealed tube. Benzyl amine was isolated as the hydrochloric salt and analyzed. This amine gave a positive isonitrile test.

TABLE No. 1

Text No.	Compound.	Formula.	M. P. Nitrogen, percent.		
			°C.	Calc.	Found.
I	2-(4-Nitro-2-methyl-phenylamino)-4-thiazolidone	$C_{10}H_9N_3O_3S$	172	16.73	16.88
II	2-(4-Nitro-2-methyl-phenylamino)-5-benzal-4-thiazolidone	$C_{17}H_{13}N_3O_3S$	230	12.38	12.23
III	2-(4-Nitro-2-methyl-phenyl)-2-methyl-amino-4-thiazolidone	$C_{11}H_{11}N_3O_3S$	158	15.84	15.76
IV	2-(4-Nitro-2-methyl-phenyl)-2-methyl-amino-5-benzal-4-thiazolidone	$C_{18}H_{15}N_3O_3S$	238	11.89	11.71
V	2-(4-Nitro-2-methyl-phenylimino)-3-methyl-4-thiazolidone	$C_{11}H_{11}N_3O_3S$	93	15.84	16.02
VI	2-(4-Nitro-2-methyl-phenylimino)-2-methyl-5-benzal-4-thiazolidone	$C_{18}H_{15}N_3O_3S$	197	11.89	11.76
VII	2-(4-Nitro-2-methyl-phenyl)-2-ethyl-amino-4-thiazolidone	$C_{12}H_{13}N_3O_3S$	128	15.10	15.35
VIII	2-(4-Nitro-2-methyl-phenylimino)-3-ethyl-4-thiazolidone	$C_{12}H_{13}N_3O_3S$	86	15.10	15.11
IX	2-(4-Nitro-2-methyl-phenylimino)-3-benzyl-4-thiazolidone	$C_{17}H_{15}N_3O_3S$	98	12.31	12.22
X	2-Methyl-4-nitro-6-bromo-chloroacetanilide	$C_9H_8BrClN_3O_3$	202	9.10	9.16
XI	2-(6-Bromo-4-nitro-2-methyl-phenylamino)-4-thiazolidone	$C_{10}H_8BrN_3O_3S$	223	12.73	12.66
XII	2-(6-Bromo-4-nitro-2-methyl-phenylimino)-3-methyl-4-thiazolidone	$C_{11}H_{10}BrN_3O_3S$	204	12.21	12.24
XIII	2-(6-Bromo-4-nitro-2-methyl-phenylamino)-5-benzal-4-thiazolidone	$C_{17}H_{12}BrN_3O_3S$	above 250	10.05	9.99
XIV	2-(6-Bromo-4-nitro-2-methyl-phenylimino)-3-ethyl-4-thiazolidone	$C_{12}H_{12}BrN_3O_3S$	164	12.10	12.05
XV	2-(6-Bromo-4-nitro-2-methyl-phenylimino)-3-benzyl-4-thiazolidone	$C_{17}H_{14}BrN_3O_3S$	172	10.00	9.84

SUMMARY

The thiazolidones from (p)nitrotoluidine and the 6-bromo-(p)-nitrotoluidine and a number of other derivatives have been prepared.

The methylation and ethylation of the (p)nitrotolyl thiazolidone gave the 2-alkyl-2-nitroaryl-amino and in larger amount the 2-aryl-imino-3-alkyl thiazolidones. However, with benzyl chloride only the 3-benzyl derivative was obtained.

In the case of the bromo-nitro-tolyl thiazolidones from the action of methyl iodide, ethyl iodide, and benzyl chloride on the sodium salt, only the 3-methyl, 3-ethyl, and 3-benzyl isomers were isolated, thus showing the effect of the bromine and nitro substituents.

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On the Alkylation of the 2-phenylimino-5-dimethyl-Thiazolidone and the 2-phenylimino-4-phenyl-Thiazoline

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Contribution from the Chemical Laboratory of the University of Kansas

IN a recent paper (1) a study was made of the 2-phenylimino-4-diphenyl-thiazolidone in order to ascertain the effect of substituting the methylene hydrogens at 4- with phenyl groups—and it was found that the compound behaved normally, yielding on alkylation derivatives with alkyl groups at positions 2- and 3-. The following paper records some additional observations on the analogous dimethylthiazolidone where the phenyl groups were replaced by methyl. In this case, however, only the 2-phenyl-2-methyl-aminothiazolidone was isolated and none of the 3-methyl isomer. On the other hand, alkylation of the 2-phenylimino-4-phenyl-thiazoline gave only the 3-methyl compound and none of the 2-methyl isomer.

EXPERIMENTAL

PREPARATION OF THE ETHYL ESTER OF ALPHA-BROMO ISOBUTYRIC ACID. $(CH_3)_2CBrCOOC_2H_5$

Isobutyric acid was converted into bromo-butyryl bromide on treatment with bromine and red phosphorus.

Since the acid bromide could not be distilled without decomposition even under reduced pressure, it was treated with absolute alcohol and converted into the ester. From sixty grams of this acid an eighty-gram yield of the ester boiling between 160-70° was obtained.

(1). Eberly and Dains, Jour. Am. Chem. Soc., vol. 58, 2544, 1936.

2-PHENYLIMINO (OR AMINO)-5-DIMETHYL-4-THIAZOLIDONE, I

$$SC(NC_6H_5)NHCOC(CH_3)_2$$

Monophenylthiourea (15 gms.), dimethyl-bromoacetic ester (20 gms.), and pyridine (8 gms.), in acetone (100 c. c.), were refluxed for four hours with little effect; the acetone was then replaced with benzene and the refluxing continued for twelve hours.

Removal of the benzene by steam distillation left a gummy residue. This was soluble in hot sodium hydroxide solution (10%) and on cooling, the crystalline sodium salt of the thiazolidone separated.

From a solution of the sodium salt, in hot water, the free base was precipitated by the addition of hydrochloric acid. Excess of acid dissolves the thiazolidone, but it can be reprecipitated from the acid solution by making it alkaline with ammonia.

From alcohol it crystallized in colorless needles, melting at 172°.

Analyses: Calcd. for $C_{11}H_{12}N_2OS$: N, 12.72.

Found: N, 12.87, 12.48.

METHYLATION OF THE SODIUM SALT OF I. FORMATION OF 2-PHENYL-2-METHYL-AMINO-5-DIMETHYL THIAZOLIDONE II

$$SC(NC_6H_5CH_3)NCOC(CH_3)_2$$

The dry sodium salt was heated with an excess of methyl iodide in absolute alcohol for several hours. Dilution of the reaction mixture with water and evaporation of the excess methyl iodide and alcohol gave an oil that slowly solidified. It was completely soluble in dilute acid, thus showing the absence of the 3-isomer.

Crystallized from hot dilute alcohol, it formed colorless prisms that melted at 145°.

Analyses: Calcd. for $C_{12}H_{14}N_2OS$: N, 11.97.

Found: N, 12.05.

Its structure was proven by its synthesis from unsymmetrical methyl-phenylthiourea. Equivalent amounts of the thiourea, ethyl bromoisobutyrate and pyridine were refluxed in alcohol solution. From the reaction mixture was isolated the above thiazolidone II.

2-PHENYLIMINO-4-PHENYL-THIAZOLINE III

$$SC(NC_6H_5)NHC(C_6H_5)CH$$

It will be noted that while this compound has the grouping $SC(NC_6H_5)NH$, which is found in the preceding thiazolidone, it differs in having no oxygen at 4- and a double bond between carbons

4 and 5. In consequence, the chemical behavior of the compound is distinctly modified.

PREPARATION

Twenty grams of phenacyl bromide were dissolved in alcohol and added slowly with constant shaking to a hot solution of monophenylthiourea in alcohol. The reaction was immediate, as indicated by the vigorous boiling of the alcohol, and was completed by heating for thirty minutes. The hydrobromide of the thiazoline separated on cooling; the free base was obtained by the addition of ammonia to the hot alcohol solution of the salt and dilution with water.

The thiazoline is moderately soluble in hot alcohol, from which it deposits colorless crystals melting at 138°.

Analyses: Calcd. for $C_{15}H_{12}N_2S$: N, 11.11.

Found: N, 11.02, 11.07.

The salts of this base with hydrochloric or hydrobromic acid are slightly soluble in hot water, but readily in hot alcohol. All attempts to prepare a sodium salt of this thiazoline analogous to those of the thiazolidones were fruitless. However, the results of methylation and the action of carbon disulfide point to a 2-phenylimino structure.

The work is in correlation with that of Traumann (2) who found that chloro-acetone or dichloro-ether reacted with monophenylthiourea giving an analogous 2-phenylimino-thiazoline and that of Naf (3) with dichloro ether and the monoalkylthioureas.

METHYLATION OF 2-PHENYLIMINO-4-PHENYL-THIAZOLINE. FORMATION OF 2-PHENYLIMINO-3-METHYL -4-PHENYL THIAZOLINE IV

$SC.(NC_6H_5)NCH_3C.C_6H_5\text{-}CH$

Ten grams of the free base III and eight grams of methyl iodide were heated for five hours at 140-50°.

Extraction of the reaction product with hot water and purification by crystallization from the same solvent gave a poor yield of the thiazoline IV. The plates melted at 171°.

Analyses: Calcd. for $C_{16}H_{14}N_2S$: N, 10.52.

Found: N, 10.56, 10.43.

Its structure was confirmed by its synthesis from symmetrical methyl-phenylthiourea and phenacyl bromide.

(2). Ann. 249, 31 C 1888.

(3). Naf. Ann. 265, 127 (1891).

In contradiction to the thiazolidones, the compound is extremely stable. It was not hydrolyzed by heating with 75% sulphuric acid or 20% hydrochloric acid at 160°.

The presence of a phenylimino group at position 2- was indicated by the formation of phenyl isothiocyanate when the compound was heated with carbon disulphide at 190-200° for four hours. (4)

2-PHENYL-2-METHYL-4-PHENYL THIAZOLINE V

$SC(NCH_3C_6H_5)NC(C_6H_5)CH$

This was obtained as a salt by the action of phenacyl bromide on unsymmetrical methyl-phenylthiourea in hot alcohol solution.

The free base crystallized from alcohol in thick needles melting at 82°.

Analyses: Calcd. for $C_{16}H_{14}N_2S$: N, 10.52.

Found: N, 10.37.

This is the usual type of product resulting from the alkylation of sodium salt of the 2-phenylamino-thiazolidone,—but none was isolated in the methylation of the thiazoline.

2-PHENYLIMINO-3-ALLYL-4-PHENYL THIAZOLINE VI

$SC(NC_6H_5)N(C_3H_5)C.(C_6H_5)CH$

Phenacyl bromide and symmetrical phenyl-allylthiourea were found to react with the formation of the above thiazoline which melted at 117°.

Analyses: Calcd. for $C_{18}H_{16}N_2S$: N, 9.55.

Found: N, 9.35.

Heating with carbon disulfide at 190-200° gave a nearly quantitative yield of phenyl mustard oil, thus showing the position of the phenyl and allyl groups. It is of interest to note that when the same allyl-phenylthiourea was treated with chloroacetyl chloride, a 2-allylimino-3-phenyl thiazolidone was formed—the position of the groups in the two cases being reversed.

SUMMARY

The methylation of the 2-phenylimino-5-dimethyl-4-thiazolidone gave only the 2-phenyl-2-methyl-amino derivative with no evidence of the 3-methyl isomer. A sodium salt could not be obtained from the 2-phenylimino-4-phenyl thiazoline, but heating at 140° with methyl iodide gave in small yield the strongly basic 3-methyl derivative, whose constitution was proven by its synthesis from the

(4). Greifenhagen, J. pr. Ch. (2) 75. 192. (1907).

symmetrical methyl-phenylthiourea. The position of the phenyl group was shown by the formation of phenyl isothiocyanate on heating with carbon disulphide.

Symmetrical allyl-phenylthiourea and phenacyl bromide formed the 2-phenyl-3-allyl-thiazoline. In the previous paper it was found that the same thiourea and chloro-acetyl chloride gave a thiazolidone with the allyl group at 2- and the phenyl group at 3-, the positions thus being reversed.

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Some Observations Regarding the Fate of Intravenously Injected Calcium Chloride

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ABSTRACT: The problem which the authors of this paper have investigated is the immediate fate of a soluble calcium salt following its injection into the blood stream of normal anesthetized dogs. The method of study is simply the repeated determination of serum calcium at varying intervals of time over a total period of approximately two to three hours immediately following the injection. Other workers are agreed that such injected calcium leaves the blood stream very rapidly at first and less rapidly later, but that approximately the normal calcium level is attained in the time mentioned. This finding is confirmed by the authors. They report that 69 percent leaves in the first five minutes and 95 percent has left in three hours. There has been some lack of agreement as to whether or not this disappearance is partly or wholly accounted for through excretion by the intestine and kidneys. Since the large intestine is believed to play the major role in excretion of calcium, tests were made to recover any excreted salt by washing out loops of the organ, but only small quantities were obtained, quite insufficient to account for the disappearance from the blood stream. Also, following the removal of the kidneys alone, the large intestine and kidneys, or the kidneys and both large and small intestine, the authors find still an early rapid disappearance of injected calcium from the blood. In case of the removal of the large intestine, however, the later disappearance of injected calcium is hindered somewhat.

To test out the proposed idea that the bones are mainly responsible for the disappearance, animals were prepared in two ways: (1) Insofar as possible, the vessels supplying the bone were ligated, leaving only the soft tissues; and (2) heart-lung preparations were made. In both these cases, the disappearance curve closely resembled that of intact animals.

These findings are discussed in connection with a theory proposed by Greville that there is at first a rapid diffusion of calcium into the tissue spaces until some kind of an equilibrium is reached, after which the disappearance from the blood is slower. Perhaps this equilibrium involves some sort of binding of the calcium in an un-ionized form. It appears, however, that

neither excretion by the intestine or kidneys nor absorption by the bones plays any significant part in these processes. The work suggests that the large intestine may have a greater "binding" affinity for the injected calcium than some other tissues.

THE calcium of whole blood is reported to be 5 to 9 mgm. percent (Lyman 1917, Kramer and Tisdall 1921, Jones 1921, Alport 1924), most if not all of which is found in the plasma (Abderhalden 1911, Leiboff 1930, Greville 1931, and others). The normal variation of serum calcium is 9 to 12 mgm. percent, the value usually being nearer 10 mgm. percent (Lyman 1917, Matz 1925, Kramer and Tisdall 1921, Kramer and Howland 1920, Watchorn 1924-'25, Esau and Stoland 1930, and many others). There is still considerable uncertainty as to the forms of calcium held in the blood stream. While that is not within the scope of the present discussion, it would seem that only a small portion of the total is ionized (Cushny 1920, Cameron and Moorhouse 1925, Richter-Quittner 1921, Brull 1930, and Benjamin and Hess 1933).

A great deal of interest has been manifest in the fate of injected calcium salts and the restoration of the calcium balance of the body. Voorhoeve (1911) appears to have been one of the first to study the tissue calcium after the administration of calcium salts. He reports the administration of calcium (as the chloride or lactate, several grams per day) increased the calcium stock of the tissues and blood, even in well-fed adults. Kost (1918), who treated growing young rabbits with calcium chloride for a week, found insignificant increases in the blood calcium and in the liver, somewhat more in the spleen, kidney and stomach, still more in the bone, muscle and intestine. Heubner (1918) found the only significant increase after calcium injection in the kidneys. Hetenyi (1924) could account for only half of the injected calcium in the blood and excretions at the end of three hours. After lethal doses he found the calcium content of the bones increased by 2 percent. Taylor and Fine (1930) could find no significant increase in the urinary excretion after calcium injection in cats nor could they recover any significant amount by washing out loops in the intestine. That injected calcium rapidly leaves the blood stream has been shown by Heubner (1918), Hetenyi (1924), Salveson, Hastings and McIntosh (1924), Rothlin (1929), Taylor and Fine (1930), Gerschmann (1930), and Greville (1931).

While it is generally agreed that injected calcium rapidly leaves

the blood stream, there is no general agreement regarding its fate. It occurred to the authors that more knowledge of the mechanism for disposing of an excess of calcium, produced by the intravenous injection of one of its soluble salts, might give some information regarding the normal metabolism of this ion. Much of the early work reported was carried out before adequate methods of calcium analysis had been devised. The purpose of the present investigation was to study again carefully the immediate fate of intravenously injected calcium chloride, making use of recent advances in the technique of calcium. The work is divided into the following parts:

1. The rate of disappearance from the blood stream of the calcium excess following intravenous injection of calcium chloride in the normal animal.

2. The rate of disappearance of calcium excess after the removal of certain visceral organs which might be concerned in its disappearance.

3. The rate of disappearance of calcium excess in preparations containing only soft tissues.

METHODS

Adult dogs kept on the ordinary laboratory diet consisting of whole-wheat bread, milk and hamburger were used in these experiments. The animals were under ether anesthesia throughout the experimental period (90 to 180 minutes); the ether being administered from an ether bottle through a tracheal cannula. One carotid was cannulated to draw blood for analysis and the femoral vein exposed for injections.

For the first part of the experiment the normal dogs were simply anesthetized and after securing a sample of normal blood the required amount of calcium chloride was injected, following which samples of blood were drawn at stated intervals. The results of the analysis of these samples for calcium are recorded in Table I. In a second group of dogs a similar procedure was carried out with the exception that in each case the kidneys were removed after the withdrawal of the sample of normal blood. A third group was studied after both the large intestine and kidneys were removed and a fourth group following the removal of the small intestine, large intestines and both kidneys. Averages of these results are shown in Table I. Some data with respect to the relative importance of the skeletal and soft parts of the body was obtained from studies of the disappearance rate of calcium from one group of dogs

in which an effort was made to tie off most of the vessels leading to the bony skeleton. Results are shown in Table V. In a final group of animals the disappearance rate of calcium was studied from the heart-lung preparation. Results are shown in Table VI.

TABLE I.—Concentration in mg. calcium per 100 c.c. of blood and in percent of the amount injected at stated periods following the intravenous injection of calcium chloride (60 mgm. per kg. body weight) into normal and partly eviscerated animals.

Time after injection of calcium chloride.	Normal (average of 3 animals).		After removal of kidneys (average 6 animals).	After removal of large intestine and kidneys (average 3 animals).	After removal of large and small intestines and kidneys (average 7 animals).	
	Mg., 100 c.c.	Percent injected.			Mg., 100 c.c.	Percent injection.
Normal.....	11.2	.....	11.1	10.3	10.7	.....
5 minutes....	21.9	69	19.9	23.0	23.9	62
15 minutes....	18.8	77	17.2	19.8	20.7	71
30 minutes....	16.4	85	15.4	18.3	18.9	76
60 minutes....	14.7	90	14.5	18.2	18.3	78
90 minutes....	13.8	92	13.7	17.4	17.9	79
120 minutes....	13.5	93	13.3	16.2	17.4	80
150 minutes....	13.4	93	12.2	.....	16.5	83
180 minutes....	12.8	95	12.6	15.4	16.1	84

In all cases serum calcium was determined by the method of Clark and Collip (1925), a modification of the earlier method of Kramer and Tisdall (1931). The calcium is precipitated directly from clear blood serum by means of ammonium oxalate. The calcium oxalate precipitated is taken up in sulphuric acid and the oxalate radical oxidized with a standard solution of potassium permanganate (n/100). The amount of permanganate required to complete the oxidation of the oxalate carried down with the calcium enables the computation of the calcium present, one cubic centimeter of n/100 potassium permanganate being equivalent to 0.2 mgm. of calcium.

At the present time this method is widely used for the determination of blood calcium and with ordinary care has been found to give quite accurate results. Greville (1931) made a careful investigation of this method. Calcium salts were added to horse serum and

run in quadruplicate with a maximum error of less than 2 percent. Recoveries of 98.4 and 97.6 percent are reported with 0.576 mgm. and 0.289 mgm. of added calcium, respectively. The serum calcium of rabbits after the injection of calcium salts were determined both by Clark and Collip technique and the wet combustion method of Widmark and Vahlquist (1931). From this evidence it may be concluded that the method as modified by Clark and Collip is adequate and convenient for the determination of serum calcium.

We see from the data (Table I), first column, that immediately after the injection of calcium salts the serum calcium is raised to high values (15 to 22.4 mgm. percent). Powers, Bowie and Howard (1930) using the congo red technique of Hooper, Smith and Whipple (1920), found the blood volume of adult dogs to be 11.28 c.c. per 100 gms. body weight, the plasma volume being 6.18 c.c. Assuming this plasma volume, we find the calcium injected should give 45.2 mgm. percent if all of it were contained in the plasma. However, at the end of 5 minutes we find not 45.2 mgm. but 21.9 mgm. percent, 57 percent having disappeared from the plasma during the first five minutes after injection. Similar results were obtained by Heubner (1923) in the cat, by Hetenyi (1925) in humans, Rothlin (1929) in rabbits, Taylor and Fine (1930) in cats, Gerschmann (1930) in dogs and Greville (1931) in rabbits, all of whom report a rapid disappearance of intravenously injected calcium salts.

Where has this calcium gone? Is it possible the corpuscles have taken up a part of the injected calcium? Abderhalden (1911) could find no calcium in the blood corpuscles of human blood. Guillaumin (1930) reports varying quantities up to 2 mgm. per 100 c.c. of blood. Heubner and Rona (1919) found up to 7 mgm. percent in the corpuscles following the injection of calcium salts. Greville (1931) found in rabbits, after the injection of calcium salts, the quantity of calcium carried down with or inside the corpuscles on centrifuging to be negligible. Results of determination made in this laboratory on whole blood, using the rapid combustion method of Bolliger (1932) compared with serum calcium determinations made by the method of Clark and Collip (1925), are in agreement with the findings of Greville (Table II). A large portion of the injected calcium has left the blood stream.

TABLE II.—Analysis of whole blood for calcium. Rapid combustion method of Bolliger

Serum calcium by method of Clark and Collip., mgm. percent.	Analysis of whole blood. Calcium in mgm. percent, assuming the total in the plasma.
10.2	9.8
17.4	17.7
22.8	24.0
23.2	24.0
22.9	21.5

Is the injected calcium excreted through the intestine and kidneys sufficiently rapid to account for its disappearance from the blood stream? That calcium is normally excreted by the kidneys and the epithelium of the large intestine has been well established by Rey (1894-'95), Patterson (1908), Cushny (1918), Nelson (1916), Husband, Godden and Richards (1923), to mention only a few. Bergeim (1926) has definitely shown that in the rat there is an absorption of calcium along the small intestine and an excretion by the epithelium of the large intestine. Hetenyi (1924) believes calcium is normally excreted, for the most part, by the large intestine, the ratio of large intestine to kidney excretion varying from 10 to 1, to 20 to 1. They state further this ratio may be influenced in favor of the kidneys by many factors. Stewart and Percival (1927) found the calcium excretion by the large intestine of the cat to be 0.33 to 0.9 mgm. in a three-hour period. During the same period the kidneys excreted 0.14 to 0.25 mgm. Walsh and Ivy (1927) studied calcium excretion in dogs with pouches (Thiry-Vella). Daily washings of the upper jejunum gave 0.32 to 1.2 mgm. of calcium, lower ileum 2.0 to 8.5 mgm., the entire colon 1.8 to 15 mgm. daily.

It is evident there are many difficulties to an accurate study of normal calcium excretion. The fecal calcium represents unabsorbed calcium as well as excreted calcium. Bergeim (1926), as mentioned above, has shown both absorption and excretion take place in the intestine. There is little or no agreement as to the relative importance of these two processes in normal animals.

Similarly there are many factors which complicate the study of urinary excretion. Brull (1930) found the excretion of calcium in the urine to be proportional to the rate of urine secretion, the excreted calcium acting like a "no-threshold" substance. Not only

kidney activity but the composition of the diet may alter urinary calcium. Bogert and Kirkpatrick (1922) found base-forming diets caused a decrease in the urinary calcium and an increase in the fecal excretion, while the reverse was found true of acid-forming diets. Stehle (1917) found an increased excretion of calcium in the urine of dogs after the ingestion of hydrochloric acid.

But what of the excretion following the injection of calcium salts? Rey (1894-'95) stated that after intravenous injection of calcium salts 53 percent could be recovered from the colon in three days. Hetenyi (1924) found after intravenous injection of calcium salts slightly more fecal calcium than in control animals. There was little or no effect on urinary output of calcium. Salveson, Hastings and MacIntosh (1924) found fecal excretion of calcium during the six days following a large injection of calcium chloride lower than that before the injection. Taylor and Fine (1930) studied calcium excretion in the cat. They observed that injected calcium chloride disappeared rapidly from the blood stream, but did not find any change in the excretion through the kidneys or intestine. They state further that evisceration or tying off the kidneys had no effect on the rate of disappearance of calcium salts. In view of the rapid disappearance of injected calcium salts immediately after injection (60 to 70 percent during the first five minutes) and the general lack of agreement regarding the excretion of calcium salts, the authors considered it worth while to reinvestigate the possibility of excretion playing a role in this rapid disappearance from the blood stream.

In a series of six dogs, the kidneys were removed. All experiments were performed under conditions previously described. Calcium chloride (60 mg. per kilogram body weight) was injected intravenously. Samples of blood were drawn at regular intervals and the serum analyzed for calcium.

The data in Table I, second column, strongly suggests that the kidneys play a minor role, if any, in the removal of the injected calcium within the experimental period (three hours). The possibility of a compensatory increase in intestinal excretion after removal of the kidneys will be considered in another place. Hetenyi (1924) recovered 9 to 18 percent of the injected calcium from the urine after three hours. Brull (1930) found no increased output of calcium salts in the urine formed by a heart-lung-kidney preparation. He believes the urinary output of calcium is dependent upon the rate of urine formation and not upon its concentration in

the blood stream. Taylor and Fine (1930) injected calcium intravenously in cats. They could not account for its disappearance through excretion by the kidneys. These observations justify the conclusion that the kidneys play no important role in the rapid disappearance of intravenously injected calcium salts.

In three dogs the large intestine as well as the kidneys were removed. The averages of the serum calcium determinations are shown in the table. (Table I, column 3.)

Examination of the data shows a consistently slower rate of disappearance in the animals with the large intestine and kidneys removed, this difference becoming more marked the longer the time after injection. As in groups previously reported, there is a rapid disappearance during the first few minutes following injection of calcium chloride. However, the slower process, the restoration of the calcium balance, is the portion most influenced.

In some manner, the removal of the large intestine hinders the return of serum calcium to the normal level. This will be discussed later. There is necessarily some loss of blood in the removal of a part of the intestinal tract. In these experiments that was not considerable. To determine the effect of this on the rate of disappearance of injected calcium the following experiment was run:

A dog was anesthetized and prepared for injection and bleeding as previously described. Before injecting calcium chloride the animal was bled 250 c. c. of blood and then a disappearance of injected calcium determined as previously described. The following results were obtained:

TABLE III

Time, in minutes, following injection	Serum Ca. Mgm. percent
N	11.3
5	23.4
30	17.5
50	16.1
60	15.9
90	15.0
120	14.5
150	13.7
180	12.7

Using the values for blood volume of the dog found by Powers, Bowie and Howard (1930), 250 c.c. in this animal represents 17.8 percent of the circulating volume. Inspection of the above data shows the disappearance of calcium to be normal. It is unlikely that in any evisceration experiments here reported there was a loss of blood as great as that reported here. While it is impossible to

say if impaired circulation may not have been in part responsible for the slower disappearance from the blood stream, yet it may be pointed out that the exposure and manipulation of the viscera in removing the kidneys did not alter the rate of disappearance.

Is the difference in the rate of disappearance a general result of the loss of tissue or a specific effect from removal of the large intestine? Would the removal of the small intestine as well as the large intestine alter this rate of disappearance further? To give some information regarding this possibility the small intestine was removed (up to the tail of the pancreas) as well as the kidneys and large intestines. The averages of serum calcium after the injection of calcium chloride are given in the table. (Table I, column 4.)

The rate of disappearance of injected calcium here is slightly slower than that reported in column 3. Considering the mass of tissue removed with the removal of the small intestine, it would seem there is a great difference in the affinity of tissues for calcium if the difference observed is due to some tissue "binding" of calcium. There are three rather obvious possibilities to be considered:

1. That the intestines excrete a portion of the calcium excess and that this excretion is considerable immediately after injection.

2. That these tissues take up and hold a portion of the calcium excess.

3. That both 1 and 2 occur.

We will consider the first of these possibilities in the next series of experiments to be reported.

As we see from an earlier review of the literature on calcium excretion by the intestine, increases in the rate of excretion of calcium following the injection of one of its soluble salts was reported by Rey (1894-'95) and by Hetenyi (1924) more recently.

Stewart and Percival (1929) studied the normal calcium excretion in cats by isolation of segments of the intestine and washing out the excreted material at intervals. Similar studies were made by Walsh and Ivy (1927-'28) in the dog using Thiry-Vella pouches. Both report a small normal excretion. Taylor and Fine (cf. above) using the technique of Stewart and Percival, studied the excretion of calcium in cats after the intravenous injection of calcium chloride. They state, "The disappearance cannot be accounted for by excretion through the bowels or kidneys." They believe the injected calcium does not leave the body. Since the removal of the

intestines does alter the rate of disappearance of injected calcium salts, it is imperative that the possibility of their excretion be studied.

The method of study used here is essentially the same as that used by Taylor and Fine. The kidneys were removed and the large intestine cannulated, carefully cleaned of all contents and washed with warm physiological saline until absolutely clear. A last portion of the washings was saved and analyzed for calcium. After three hours from the time of calcium injection (60 mgm. $CaCl_2$ per kilogram body weight was injected in all cases) the large intestine was again washed out with 500 c.c. of warm physiological saline, the saline being run through the intestine three times. Ten cubic centimeter portions of the clear washings were taken for analysis. To this was added 2 c.c. of 4 percent ammonium oxalate and after standing 24 hours in the ice box centrifuged and titrated according to the technique of Clark and Collip (previously described).

The results from all dogs in which calcium excretion was studied are shown in tabular form below. (Table IV.)

TABLE IV.—The excretion of intravenously injected calcium by the epithelium of the large intestine. Recovery experiments

Number of Experiment.	Serum calcium.		Calcium excreted, large intestine, in 180 minutes.
	Before injecting calcium.	5 minutes after injecting calcium.	180 minutes after injecting calcium.	
	mgm.	*mgm.*	*mgm.*	*mgm.*
27	11.8	21.4	13 3	7.6
29	12.6	21.5	14.8	1.4
33	10.3	23.0	.....	2.0
37	10.4	18.9	11.8	1.43
38	11.2	16.3	14.3	2.8
44	Control	.....	.....	Trace

Walsh and Ivy (1927-'28) have shown that repeated washing increases the calcium excreted into the large intestine. In the experiments here reported, the calcium excreted was calculated by substracting the amount in the last portion of the first washing from the amount obtained after three hours, on the assumption that this represents the amount excreted due to the washing out.

While these values are a little higher than those of Taylor and Fine (1930) who reports 0.77 mgm. in one experiment on a normal dog (studied excretion in the cat) yet they are in agreement in that they show only a small amount of the injected calcium has been excreted in the experimental period. Examination of Table I shows

a difference in serum calcium between normal dogs and those in which the kidneys and large intestine had been removed of 2.6 mgm. percent. In the case of a dog of average size (12 kilograms) there should be about 741 c.c. of plasma which would contain, after injection, a total of 19.2 mgm. of calcium more than the normal amount. This represents the loss attributable to the large intestine. We see that the greatest recovery reported here is 7.6 mgm. with 3.06 mgm. as an average value. If the intestine excretes as much as 19.2 mgm. of calcium it was not recovered from the washings in our experiments. The small amount excreted in our experiments is wholly inadequate to explain the rapid disappearance that occurs during the first five minutes after injection. Since the kidneys were removed in these experiments, we must conclude a large portion of the injected calcium is retained in the body.

Since the calcium leaves the blood stream and since it is retained in the body we have the possibility of:

1. Diffusion into the soft tissues.
2. Deposition in the bones.
3. Both diffusion into the soft tissues and deposition in the bones.

Greville (1931) suggested that both processes do occur. He believes that there is first a rapid diffusion into the tissue spaces until there is some form of equilibrium between the calcium in these spaces and the raised blood calcium. The calcium then disappears from the tissue spaces and blood stream, the rate of disappearance at any given instant being proportional to the excess present.

If this be correct, the first part of the disappearance curve would take place in the complete absence of the skeletal system. The amount of calcium leaving the blood stream would be proportional to the amount of calcium injected and the amount of soft tissues taking part in the reaction. The next series of experiments will consider this possibility.

In all dogs used in these experiments the thorax was opened under ether anesthesia and the animal kept alive by artificial respiration. The blood vessels to the extremities, all vessels to the head except the internal carotids and all vessels to the dorsal body wall were tied off. The intercostals were ligated from the opened thorax. The vessels to dorsal abdominal wall were exposed by an incision into the abdominal cavity through the dorsal wall. These were then dissected from other tissue near their origin from the abdominal aorta and ligated. This procedure was found to disturb the abdominal viscera the least.

Calcium chloride in a 5 percent solution was injected into the jugular or subclavian vein near the heart. Blood was drawn at regular intervals thereafter and analyzed for calcium as previously described.

Table V gives the results of seven experiments in which the above technique was employed. It is obvious from the examination of this data that there is a rapid disappearance of injected calcium from the blood stream during the first five minutes after injection and that the bony tissues play no role in this. In the past it was generally believed calcium salts decreased the permeability of the capillary wall. That this is not the case has been shown by Yanagawa (1916), Bayliss (1918) and Smith and Mendel (1920). That calcium does penetrate the wall of the capillaries has been shown by Arnold and Mendel, who demonstrated its appearance in oedema fluid and serous transudates. Thus, there is little doubt but that

TABLE V.—The disappearance of intravenously injected calcium chloride after tying off the blood vessels to the skeleton (including some skeletal muscle)

NUMBER OF EXPERIMENT.	Calcium injected per 100 c.c. plasma, mgm.	Calcium in mg. percent 5 minutes after injection.	Calcium leaving blood, in percent injected.			
			5 minutes.	30 minutes.	60 minutes.	180 minutes.
36	66	25.4	77	78	.....	.....
40	55	19.0	83	.....	.....	87
41	47	27.8	64	.....	.....	78
43	50	31.8	57	72	.....	76 (145 min.)
45	38	28.2	55	.....	58	.....
49	45	30.5	55	69	.....	.....
50	50	38.0	44	48	.....	.....

there is a rapid diffusion out into the tissue spaces of a large amount of the injected calcium. It would seem that during the first few minutes some equilibrium is reached between the blood and tissues after which only slow changes in the concentration toward normal occur. Certainly the nature of these processes whereby calcium is taken out of circulation and held by the soft tissues invites more study. This study is only a beginning in the study of tissue calcium. Future work must deal with the problems of the normal content of various tissues and the tissue spaces, the forms in which it is held in the tissues and the role it plays in normal cell metabolism.

Having shown that there was a rapid disappearance of injected calcium in preparations containing only soft tissues, it would be interesting to see if a similar thing would occur in preparations containing only a few organs. The heart-lung preparation of Starling offers an ideal opportunity to do just that. The data from three satisfactory preparations is given in the table below. (Table VI.)

TABLE VI.—The disappearance of calcium added as calcium chloride to a Starling heart-lung preparation

Number of Experiment.	Calcium injected per 100 c.c. plasma.	Normal serum calcium in mgm. percent.	Serum calcium in mgm. percent 5 minutes after injection.	Percent injected calcium leaving blood first 5 minutes.	At other periods, calcium in mgm. percent.
	mgm.	mgm.	mgm.		
28	43	7.8	33.8	39.5	After 45 min., 28 mgm.
32	28.8	8.4	23.0	49.3	After 75 min., 20.0 mgm.
53	42.0	8.0	27.0	54.7	After 53 min., 18.2 mgm.

A comparison of the disappearance curves obtained in normal dogs with those in which the skeleton had been tied off from the circulation and with the heart-lung preparations shows in general the same contour, particularly during the first few minutes after injection. There is first a rapid fall immediately after the injection of calcium chloride and then a very slow decrease. It will be seen from an examination of both Tables V and VI that there is still some further loss of blood calcium after the first few minutes, although this takes place more slowly. In experiment 53 (heart-lung) there was a loss of 8.8 mgm. between the 5th and 53d minutes and in number 43 (soft tissue preparations) there was a loss of 3.8 mgm. between the 5th and 145th minutes. While it has been shown that the bone trabeculae stores calcium on a high calcium diet (Bauer, Aub and Albright 1929) this process may be much slower than the rate of disappearance here observed. These experiments show that there is a rapid loss of injected calcium salts from the blood stream, this taking place in the complete absence of bone tissue.

The data here reported is in general agreement with the hypothesis of Greville (1931), who suggested, on the basis of the normal disappearance curve, that there is a rapid diffusion into the tissue spaces until some kind of an equilibrium is reached between these and the blood stream. It may be further stated, that there is a

rapid diffusion into the tissue spaces until some kind of an equilibrium is reached between these and the blood stream. It may be further stated, that there is a rapid diffusion into the tissue spaces immediately after injecting a hypertonic calcium chloride solution followed by some slower process which is capable of further reducing the blood calcium below the level resulting from the rapid diffusion into the tissue spaces. Just what this process is, it is not possible at the present time to say. It does not involve the skeleton, although the bones may be necessary before calcium equilibrium can be regained.

Our knowledge of the calcium content of the soft tissues is all too meager. That it is very variable was first shown by Parhon, Dumitresco and Nissipesco (1909) and since confirmed by Rona and Heubner (1918). The calcium content of the tissues was reported increased following high calcium intake by Voorhoeve (1911). Similar findings are reported by Kost (1918) for some organs (blood, liver, spleen, kidney and intestine). Huebner and Rona (1923) made a careful analysis of the tissues of cats for calcium after chronic and acute poisoning with calcium chloride. They could find no significant increase in their calcium content. However, since their animals were not killed for analysis until 2 to 18 hours after the last calcium injection, it is possible that the calcium equilibrium of the tissues had been restored to or near normal. Hecht (1924) and Jungmann and Samter (1924) report similar findings after calcium chloride, acetate or hexose phosphate. Yet, examination of their data shows increases in the skin in some instances, large amounts of calcium in the small intestine and the kidneys, particularly after the injection of calcium hexose phosphate. Hetenyi (1924) believes he can account for 78 percent of the injected calcium in the bones at the end of three hours. There is no general agreement regarding normal calcium content of the tissues or the effect of injection of calcium on that content. Having demonstrated the rapid disappearance of the calcium excess into the soft tissues from the blood stream, a preliminary study was made of the calcium content of some of these in an attempt to detect this increase which must have occurred.

METHOD

Various methods of tissue analysis for calcium have been published. A few of the more recent ones are: Jansen (1918), Barral and Barral (1928) and Widmark and Vahlquist (1931). Most of the earlier methods required incineration to destroy the organic

material. Widmark and Vahlquist (cf. above), however, devised a technique of analysis in which the destruction of the organic material was carried out in solution by the addition of sulphuric and nitric acids. Calcium was determined by the ordinary oxalate-permanganate method after the complete oxidation of the organic material. The method used in this laboratory makes use of the Bolliger (1932) technique for the rapid digestion of biological materials. The material (usually 4 to 7 gms.) is oxidized with perchloric and nitric acids until practically colorless, neutralized to methyl red with ammonium hydroxide and made up to 25 c.c. volume. To a 10 c.c. portion in a conical centrifuge tube, 2 c.c. of 4 percent ammonium oxalate is added, mixed and allowed to stand over night. This is then centrifuged for 15 minutes at about 2,000 revolutions per minute. After washing (cf. the method of Clark and Collip, 1925) the calcium oxalate is dissolved in 3 c.c. of approximately normal sulphuric acid and titrated with n/100 potassium permanganate solution, each cubic centimeter of this being equivalent to 0.2 mgm. of calcium.

A few studies were carried out to determine the calcium content of both normal tissues and those following the injection of calcium chloride. However, such wide variations were found in normal values that, considering the amounts of calcium which were injected, the data obtained following calcium injection was not very significant. It suggests that there is somewhat greater accumulation of calcium in certain organs, viz.: the heart, lungs and small and large intestine.

Examination of Table I, column 3, shows that the removal of the alimentary tract below the pancreas greatly interferes with the return of the serum calcium to normal levels although there appears to be a rapid diffusion from the blood stream during the first few minutes following injection (62 percent of the injected calcium being removed during the first few minutes following injection, which compares favorably with controls in which 69 percent was found to have left the blood stream during the same period). Whereas, in the intact animal 95 percent had left during the first three hours, in those without kidneys or alimentary tract below the pancreas only 84 percent had been removed from the circulation. Analysis of the large and small intestines for calcium in the experiments here reported suggest the calcium content of these may be significantly higher thirty minutes after injection (when the experiments were terminated). While more study is required on this point, yet there is a suggestion from this and previous data given that these organs

are capable of "binding" a portion of the excess injected and thus holding it until it can be stored in the bones or excreted. It would thus be rendered biologically inactive (nonionized and nondiffusible). It is not improbable that this exists in some equilibrium with the blood stream so that its elimination by storage in the bones or excretion will gradually restore the calcium content of the soft tissues to normal.

DISCUSSION AND SUMMARY

Benjamin and Hess (1933) in a recently published article suggest there are four forms of calcium in the blood stream, two diffusible and two nondiffusible. Of the diffusible calcium, about two thirds is in the form of an adsorbable calcium-phosphorus complex; the remainder contains the calcium ion. Of the nondiffusible calcium, about one quarter is adsorbable and the remainder is probably bound to the plasma proteins. In hypercalcemia induced by the subcutaneous injection of calcium lactate, there was an increase in the serum calcium from a normal 11.0-11.6 mgm. percent to 15.3 mgm. percent. The protein bound fraction was not significantly altered (normal 4.3 mgm. percent was increased to 4.6 mgm. percent), but there was an increase in the adsorbable complex from a normal of 3.9-4.9 mgm. percent to 7.2 mgm. percent. The supposedly ionized portion was increased from a normal value of 2.9 to 3.5 mgm. percent. Thus we see there is a disproportionately large formation of some nonionized calcium complex following the injection of a soluble calcium salt. Brull (1930), making use of a vivi-diffusion technique, finds a similar normal partition in the blood stream. He finds a large portion of the calcium added as calcium chloride rapidly becomes nondiffusible. He further shows that the addition of an ionized salt of calcium to the heart-lung preparation causes an immediate reduction of systolic and diastolic volume and an increase in the duration of the contractions, results which would be expected from many experiments which have been performed on the heart of lower animals. However, this effect rapidly disappears and normal heart action is restored. (We have noticed a similar response in our heart-lung experiments.) Since no such accommodation as this is known to occur with the isolated heart, it suggests that the injected calcium is rapidly deionized by the organism. Miss Benjamin (cf. above) has found such a form and has shown that it is increased after the injection of calcium lactate, increased more than other forms of calcium found in the blood stream.

Thus we are led to construct the following picture of the events which occur following the injection of calcium chloride: There is a rapid diffusion of the injected calcium into the tissue spaces accompanied by the deionization of the injected calcium, possibly part of the deionized portion being represented by the calcium complex of Benjamin and Hess. Excretion plays little or no role in the rapid disappearance observed and it would seem from the work of others (Rey 1894-'95, Hetenyi 1924, Salveson, Hastings and MacIntosh 1924, Taylor and Fine 1930, and others) that a portion may be retained for several days after injection. Brull (1930) suggests there is an excretable form of calcium (not ionized). Excretion would then depend upon the production of this form rather than the presence of an excess calcium in the body fluids. After this rapid diffusion and the resultant equilibrium the calcium content of the blood and tissue spaces is considerably higher than normal. Reactions of a slower nature then become apparent—reactions which are capable of disposing of this excess. That bone, particularly cancellous bone, does take up and hold a portion of the excess calcium absorbed on a high calcium diet has been demonstrated in a series of clever experiments carried out by Bauer, Aub and Albright (1929). This suggests itself as the logical site for the storage of excess calcium removed from the blood and tissues, although a small amount may be excreted. Since calcium disappearance curves obtained from animals containing only soft tissues demonstrate both the rapid diffusion and the slower decrease in calcium which becomes apparent after this rapid diffusion, the deposition in the bones would appear to be the terminal phase of a complex reaction in which the tissues probably play an important role.

SUMMARY

1. Intravenously injected calcium chloride rapidly leaves the blood stream. Following the intravenous injection of 60 mgm. of this salt per kilogram body weight as a 5 percent solution, 69 percent was found to have left the blood stream during the first five minutes and 95 percent had left within 3 hours.

2. This rapid disappearance does not depend upon excretion, since it occurs in the absence of the intestine and kidneys. This is further confirmed by attempts to recover excreted calcium from the large intestine. Only small amounts could be obtained 3 hours after injection.

3. Removal of the large intestine in some way retards the restoration of the normal level of serum calcium after the injection of calcium chloride. The probable significance of this is discussed.

4. The rapid disappearance of injected calcium chloride observed in the intact animal can be observed in preparations containing no bone tissue. It is concluded that this reaction depends upon the blood and soft tissues alone, although the skeleton may be necessary for the restoration of the normal level of calcium in the blood and tissues.

5. Some preliminary analyses of various organs for calcium following the intravenous injection of calcium chloride lend further support to the concept that a large amount of the calcium excess may have diffused into the tissue spaces.

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Hydrocarbon Secretions and Internal Secretory Systems of the Carduaceae, Ambrosiaceae and Cichoriaceae*

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ABSTRACT: A study of the hydrocarbon secretions and secretory systems of a representative group of plants from the families Carduaceae, Ambrosiaceae and Cichoriaceae is recorded.

Based on the comparative anatomy of the internal secretory systems in the various species, it is indicated that the occurrence of specialized systems is typical of this large group of plants. The secretion systems of the species of Cichoriaceae being laticiferous while in the Carduaceae and Ambrosiaceae existing as definite canals. As a result of the anatomical study of secretory systems it has been possible to group the various species in the form of a key.

The secretions of the canals, laticiferous systems as found in the parenchyma cells which stain red with Scarlet R, are classified according to solubility with known resin, fat and caoutchouc solvents. As a result of these and saponification tests the secretions are indicated to be resinous substances.

THE secretions and secretory systems of the Carduaceae, Ambrosiaceae and Cichoriaceae (Compositae) have been the object of research of many investigators. Some of these have been impelled by the purely scientific aspects of the subject and others by the possibility of finding new sources of products of economic importance.

Early mention of the secretory system of the Compositae in botanical literature was made by Trecul (1862), who distinguished between the secretory canals and latex vessels by the fact that the latter were limited by their own walls while the former were inter-

* This work was carried out in the Botany Department of the University of Kansas under the direction of Prof. W. C. Stevens. The writer desires to make his appreciative acknowledgment to Professor Stevens for his help and encouragement during the preparation of the work here presented.

cellular spaces without any such layer. He also mentioned the occurrence of endodermal secretion canals in the Tubuliferae represented by *Vernonia praealta.*

Muller (1866-'67) confirmed the opinion that the secretory canals were intercellular spaces. In dealing with the Compositae he says of *Inula helenium* that it is distinguished by large passages in the pith containing ethereal oils and the occurrence of smaller passages in the cortex.

Van Tieghem (1885) has shown that secretory canals are of common occurrence throughout the Compositae and he emphasized the fact that in roots they are formed in close association with the endodermis. Van Tieghem states that in the Compositae the secretory system has three different forms: (1) oil-bearing canals, (2) laticiferous cells uniting in a network, and (3) isolated, long resiniferous cells; also that, aside from certain transitional forms, "Les Radiees et les Labiatiflores" have only oil-bearing canals, the Liguliflores have only anastomosing latex tubes, while the Tubuliflores, for the most part at least, have both oil-bearing canals and isolated resiniferous cells. Van Tieghem discussed the difference between the secretory canals of the stem and root. He held that the outstanding difference between the two was, that in the stem the canals were surrounded by specialized cells, while in the case of the root they were considered to be merely intercellular spaces formed in close association with the endodermis. He has recorded *Ambrosia trifida* as having secretion canals at the external border of each vascular bundle at the union of the pericycle with the phloem. These canals are considered by him to belong to the phloem.

Triebel (1885) gave a description of the development of the oil canals in the roots of a few members of the Compositae. He found that the formation of the canals was always preceded by the tangential division of the endodermal cells opposite the phloem, the canals beginning as minute intercellular spaces at the junction of the radial and newly formed tangential walls. These canals became filled with drops of almost colorless oil at a very early stage. The cells surrounding the oil canals had thinner walls and were much shorter than those of the cortex proper, they were meristematic in appearance, being filled with dense protoplasm. He considered that these cells probably played an important part in the secretion of the oil in the canals. The oil was termed an ethereal oil, a conclusion

based on the following facts: (1) that most of the plants examined had a characteristic smell, (2) that the oil was soluble in alcohol, and (3) that it stained with alkanet.

Col (1899-1904) studied the secretory apparatus mainly from the point of view of the classification of the group. He brings to light the following main facts: (1) a survey of the secreting apparatus of the different tribes of the Compositae shows that according to the phyllogenetic progression one finds a gradual replacement of secretion canals by a laticiferous system; however, the transition is not an equal gradation in the roots, stems and rhizomes. The transition takes place first in stems, then in rhizomes and roots. (2) Secretion sacs or pockets are simply reduced secretion canals, differing only in longitudinal extent. (3) There are really only two forms of internal secreting apparatus in the Compositae, the canals and anastomosing letex tubes. The occurrence of sacs or pockets and of solitary tubes more or less branching is evidence of either advancing or regressive evolution. Col also distinguished three classes of secreting apparatus: (1) anastomosing latex vessels, (2) secretory canals, (3) isolated cells which secrete latex.

Work by Tschirch (1906-1934) on resins was, for the most part, concerned with the resin and resin ducts of the Coniferae. However, his observations included some on the secretory canals of Compositae. He concluded, as a result of this work, that resin formation in the Coniferae took place in what he termed as "resinogener Schicht," which he found lining the canals. He considered that the same layer was present in the secretory canals of the Compositae, but he called this a "Schleimschicht" or mucilage layer, and it was this layer that was supposed to excrete the resin into the canal. He considered that the young resin canals were filled with mucilage before any resin is secreted and that the older secretion canals were lined somewhat evenly with mucilage. In this layer numerous droplets of the secretion were thickly embedded and the cavity surrounded by the mucilage layer contained the most of the secretion. Tschirch was of the opinion that the secretion of resin droplets takes place only in the resin canals and not in the epithele cells.

Moenike's (1924) chief object in his research was to clear up the formation of secretions in the Umbelliferae, Compositae and Araliaceae, and to prove up on Tschirch's idea of there being a resinogenous layer, and that the secretion does not occur in the epithele

cells, but in the resin canals. He considers that there is no resinogenous layer in any of the above-mentioned families. Moenike did not observe a mucilage layer in the canals of Compositae. He held that the epithele cells do contain resin droplets, although extraordinarily minute. By chemical and solubility tests he shows that the droplets in the epithele cells and the resin in the canals are the same substance, and so concludes that the resin is secreted in the epithele cells and then transferred to the canals. Moenike does not know how the droplets get through the wall of the epithele cells when they are excreted into the resin canals. He finds droplets of the secretion adhering to the walls bordering the resin canal just where the droplets accumulate in the epithele cells. Another object of Moenike was to determine the nature of the secretions in the secretion canals of the roots of the Umbelliferae, Compositae and Araliaceae.

Tetley (1925) in more recent work on the roots of the Compositae has discussed the formation of the canals and attempted an interpretation of her observations in the light of work which has been done on the endodermis. She classifies the secretion canals in the roots into two main groups: (1) endodermal, and (2) nonendodermal. The canals are said to be invariably formed opposite the phloem in very early stages. Microchemical studies of the secretion are discussed. She considers the saponification test which Moenike used as unfeasible, due to the minute quantity of substance secreted within the cells. However, she concludes that in developmental stages the secretion is a fatty substance with the nature of an unsaturated drying oil. Various theories of the method of deposition of the secretion in the canals are discussed, and she concludes that the fat is released during the differentiation of the phloem, from which it passes outwards across endodermis by way of the radical walls to the endodermal canals in which it is deposited.

Lloyd (1932), in an investigation of caoutchouc in *Parthenium argentatum,* discusses possible uses of the secretion to the plant. He feels that very little evidence has been shown for its being used in the metabolic processes of the plant or as an aid to drought resistance.

Whitaker (1922), in the study of the anatomy of certain goldenrods, states, "Another point of interest, which is of course a common anatomical character of the Tubuliflorae, is the presence of oil canals in the pith and cortex, or in both."

COMPARATIVE ANATOMY OF THE INTERNAL SECRETORY SYSTEMS IN THE VARIOUS SPECIES

Agoseris cuspidata

Root. Latex tubes are scattered throughout the phloem and cortex.

Stem. Latex tubes occur in the phloem and on the inside of, and lying in contact with, a slightly suberized endodermis. The suberized endodermal cells are decidedly tangentially flattened.

Latex tubes are also found in the pith in association with isolated groups of phloem.

Leaf. Latex tubes are found below each of the veins and in midrib. Those associated with the veins are in contact with the phloem. In the midrib the tubes are next to the group of primary hard bast beneath the phloem.

Ambrosia elatior L.

Root. Relatively small, inconspicuous canals averaging .015 mm. in cross diameter are found in the inner cortex, being more numerous radially opposite the phloem strands.

Stem. Canals averaging .015 mm. in cross diameter occur within the stem cortex lying alternate with the groups of primary hard bast (Plate III, fig. 5).

Leaf. No specialized secretory system is present.

Ambrosia trifida

Root. Numerous canals without a differentiated epithele cell layer are found in the inner cortex and phloem which average .015 mm. in cross diameter (Plate I, fig. 2). Those of the inner cortex on the root are grouped radially opposite the phloem strands.

Stem. Canals in the cortex, phloem and pith. Those of the cortex are comparatively few, numbering from four to five as seen in cross section. The average canal is .03 mm. in cross diameter and is surrounded with approximately two rows of secreting cells.

Canals of the phloem are very inconspicuous, as their epithele cells are about the same size and shape as the cells of the surrounding phloem parenchyma. The canals average .007 mm. in cross diameter and there may be from one to several canals within the phloem of each bundle.

In the pith the canals are located near the protoxylem points at the inner margin of the rays and are comparatively small, averaging .009 mm. in cross diameter. They have a definite epithele cell layer composed of from five to eight cells.

Leaf. Canals are found in the midrib only, one in the ground tissue and several in the phloem. The one occurring in the ground tissue is similar to those in the stem cortex. Its position is below the central vascular bundle. Around this canal are two to three layers of secreting cells which are filled with a dark-brown substance. These canals average .02 mm. in cross diameter. The canals of the phloem are quite small and obscure, averaging .01 mm. in cross diameter. There are often several of these canals in the phloem of a single vascular bundle.

Amphiachyris dracunculoides

Root. There is a suberized endodermis, but no specialized secretory system is present.

Stem. The canals, averaging .05 mm. in cross diameter, occur within the cortex only and often lie in an indentation of the endodermis. They have a definite epithelium with some cells joined with the suberized endodermis.

Leaf. One canal occurs beneath each of the larger veins of the leaf blade and one in the ground tissue of the midrib (Plate V, fig. 3), those below the veins having their epithelium cells in contact with the phloem. An average canal of the midrib is .05 mm. in cross diameter and an average canal of the mesophyll is .03 mm. in cross diameter. The single canal of the midrib has the same position in relation to the phloem as have the canals beneath the veins.

Aster azureus

Root. Canals, averaging .012 mm. in cross diameter, are found located radially opposite the phloem, their epithelium cells lying in contact with the suberized endodermis.

Stem. There is a suberized endodermis, but no specialized secretory system.

Leaf. Only one canal is found in the leaf, lying in the ground tissue on the lower side of the vascular bundle of the midrib. The average cross diameter was .003 mm.

Aster ericoides

Root. There is no specialized secretory system.

Stem. Canals, averaging .03 mm. in cross diameter, occur in the stem cortex with their epithelium cells lying in contact with a suberized endodermis.

Leaf. Canals are present in both midrib and mesophyll, those of the mesophyll always occurring singly below a larger vein. Only one canal is found in the midrib, near the phloem in the ground tissue. Average canals of the leaf are .02 mm. in breadth.

Rhizome. A specialized secretory system is lacking.

Aster Drummondii

Root. No occurrence of a specialized secretory system is found.

Stem. No specialized secretory system is in evidence.

Leaf. There is no specialized secretory system.

Rhizome. There are canals averaging .045 mm. in cross diameter in the cortex, lying in contact with the endodermis.

Bidens frondosa

Root. A specialized secretory system does not occur.

Stem. Canals are found in the cortex and pith. The cortical canals are irregularly dispersed within the inner cortex, and are comparatively numerous, but relatively small, averaging .02 mm. in cross diameter. The epithelium cells are not different in shape and size from the other cortical cells; however, from one to three rows of the adjacent cortex cells contain a dark-brown substance which marks very conspicuously the position of the canals. (Plate II, fig. 1.)

The canals of the pith are very sparse and relatively inconspicuous, excepting for the fact that their epithelium cells also contain a dark-brown substance. The canals average .01 mm. in cross diameter and are surrounded with four or five epithele cells. They occur close to the protoxylem points.

Leaf. Comparatively small canals averaging .003 mm. in cross diameter occur singly on the lower side of the veins and on the midrib. These are made conspicuous by the presence of a dark-brown substance found in the epithelium cells. These cells always follow the veins of a leaf, as is plainly apparent in bleached leaves, whether or not a canal is formed.

Bidens involucrata

Root. Several relatively inconspicuous canals averaging .015 mm. in cross diameter are found in the inner cortex.

Stem. Canals occur in cortex and pith. The canals of the cortex are quite similar to those of *Bidens frondosa,* but occur radially opposite the rays. The canals average .01 mm. in cross diameter and are surrounded with from one to three rows of cells containing a dark-brown substance. These cells do not form a well-differentiated epithelium, but have the shape and appearance of the other cortical cells.

The pith canals are not so closely associated with the protoxylem points as in *Bidens frondosa,* but do lie in the outer part of the pith cylinder. These have a comparatively definite epithelium of from four to seven somewhat four-sided cells.

Leaf. Secreting cells with dark-brown contents are found conspicuous in the mesophyll and midrib of this species, as was the case in *Bidens frondosa.* The canals of the midrib are dispersed through the ground tissue with a somewhat definite arrangement in relation to the vascular system. Where the secreting cells surround a definite canal they average .005 mm. in cross diameter.

Boltonia latisquama

Root. There are all told five canals which average .015 mm. in cross diameter, occurring singly and radially opposite a phloem group, and one to three cells of the suberized endodermis compose a part of the epithelium.

Stem. The only canals present in the stem are located in the cortex. These are comparatively large, averaging .045 mm. in cross diameter. The epithelium lies in contact with a suberized endodermis. These canals number from one to four in the cortex, alternating tangentially with several large groups of primary bast fibers.

Leaf. The canals (or pockets) are relatively conspicuous and numerous in the leaf blade (Plate V, fig. 6). These average .04 mm. in cross diameter and are found singly below a vein in each case, and often are larger than the veins with which they are associated. A single canal averaging .04 mm. in cross diameter is found in the ground tissue on the lower side of the vascular bundle of the midrib.

Rhizome. Comparatively large secretion pockets averaging .15 mm. in cross diameter are found within the cortical and pith region of the thickened rootstock. These extend longitudinally approximately .15 mm.

Erigeron canadensis

Root. Very inconspicuous canals, .015 mm. in cross diameter, occur in the root radially opposite the phloem within the inner cortex.

Stem. Canals occur in both cortex and pith. The epithelium of the cortical canals lies against the suberized endodermis. An average canal is .04 mm. in cross diameter (Plate III, fig. I).

Those canals occurring in the pith are comparatively few and are dispersed throughout the entire pith cylinder. Each canal is surrounded by several layers of secreting cells. The canals are relatively small, averaging .012 mm. in breadth.

Leaf. Very conspicuous canals, averaging .09 mm. in cross diameter, occur below the veins. Where these are located the leaf is decidedly swollen, especially at the margins (Plate V, fig. 8). A single canal occurs in the ground tissue below the vascular bundle of the midrib.

Erigeron ramosus

Root. Canals averaging .018 mm. in cross diameter are found radially opposite the phloem groups. These occur in association with a slightly suberized endodermis, the endodermis furnishing the inside boundary of the intercellular space.

Stem. Canals are found only in the cortex lying against a suberized endodermis. These canals are often comparatively inconspicuous from being somewhat tangentially flattened. The average canal is .02 mm. in cross diameter. An epithelium surrounds each canal, lying immediately in contact with the endodermis. These canals are usually radially opposite the groups of primary hard bast and vascular bundles.

Leaf. Canals averaging .015 mm. in cross diameter are associated with the vascular bundles of the midrib and with the larger veins, a single canal occurring on the lower side near the phloem in each case.

Eupatorium altissimum

Root. Several comparatively small canals surrounded by four to five epithelium cells are seen in the inner cortex. These average .02 mm. in cross diameter.

Stem. Fairly conspicuous canals, averaging .05 mm. in diameter, are found only in the cortex alternate with the primary hard-bast groups which are opposite the vascular bundles.

Leaf. There are canals averaging .02 mm. in cross diameter in both mesophyll and midrib, laterally to the veins in each case.

Eupatorium urticaefolium

Root. There are two to three relatively small, inconspicuous canals averaging .015 mm. in breadth, occurring radially opposite each phloem group.

Stem. Canals occur in the cortex and pith. The canals of the cortex are found radially opposite the medullary rays and in depressions between the groups of primary hard bast. The canals are relatively inconspicuous because they and their epithelium cells are approximately the same size and shape as

the surrounding cortical cells. An average canal is .015 mm. in breadth. The innermost epithelium cells are in contact with a suberized endodermis.

In the pith the canals are located indefinitely through the outer region of the pith and are similar to those of the cortex in size and shape.

Leaf. Several comparatively inconspicuous canals occur in the ground tissue above and below the vascular bundle of the midrib. These have no well-differentiated epithelium layer and average .01 mm. in breadth; also, canals averaging .01 mm. in breadth are associated with the veins.

Euthamia camporum

Root. No specialized secretory system is present.

Stem. Canals are infrequent and occur only opposite the hard bast in the cortex, with the innermost epithelium cells in contact with the definitely suberized endodermis. The average canal is approximately .03 in breadth. In older stems these canals are very hard to find because of the tangentially flattened epithelium cells and canals.

Leaf. Relatively large and conspicuous canals, averaging .06 mm. in cross diameter, are associated with the veins on the lower side near the phloem. A single canal, approximately .03 mm. in breadth, is embedded in the ground tissue of the midrib on the lower side.

Rhizome. Canals averaging .06 mm. in breadth are found lying radially opposite the phloem groups and in contact with a suberized endodermis.

Galinsoga ciliata

Root. No specialized secretory system is present.

Stem. Canals averaging .006 mm. in breadth are found in the cortex. These are relatively inconspicuous because they and their epithelium cells are approximately the same size and shape as the surrounding cortical cells.

Leaf. Canals averaging .008 mm. in cross diameter occur singly above the veins and midrib.

Grindelia squarrosa

Root. No specialized secretory system is to be seen.

Stem. Canals are found only in the cortex in slight indentations of the suberized endodermis. They are quite inconspicuous, averaging .03 mm. in cross diameter and having no definite epithelium cell-layer. The canals are somewhat tangentially flattened against the endodermis. They occur opposite the primary hard bast which in turn is opposite the vascular bundles.

Leaf. Canals averaging .04 mm. in cross diameter are located below a few of the larger veins near the phloem. In the midrib a single canal of about the same size as the others is embedded in the ground tissue below the vascular bundle.

Helianthus annuus

Root. Tangentially flattened canals averaging .04 mm. in breadth are found in the cortex with their epithelium lying in contact with a suberized endodermis. One or more are found to occur radially opposite the phloem groups.

Stem. The canals are found in the cortex and pith. Those of the cortex are comparatively large, averaging .08 mm. in cross diameter, and are dispersed

through the cortical parenchyma with no definite position in relation to the vascular bundles. The epithelium cells have about the same shape as the surrounding cortical cells.

In the pith the canals are dispersed near its periphery and are much smaller than those of the cortex, averaging .015 mm. in breadth. They have a very definite epithelium layer composed of rectangular cells.

Leaf. The canals, averaging .04 mm. in diameter, are associated with both the veins and the midrib, occurring singly above the veins, and in the midrib there are eight canals dispersed within the ground tissue of the lower side in definite relation to the five vascular bundles.

Helianthus rigidus

Root. Numerous comparatively inconspicuous canals averaging .015 mm. in breadth occur within the inner cortex radially opposite the phloem. These lie in contact with the endodermis.

Stem. Canals are found in the cortex, phloem and pith. Those of the cortex are relatively large, averaging .09 mm. in breadth, while some are as large as .2 mm. (Plate II, fig. 3). They are dispersed in the cortex, sometimes opposite the vascular bundles, and again opposite a ray. The epithelium is very pronounced, with comparatively large rectangular cells.

The canals of the phloem also are larger than those in the phloem of most other species, averaging .012 mm. in breadth. Several canals may be found in each phloem group, each with a definite epithelium (Plate II, figs. 2 and 3).

In the pith the canals are fairly evenly dispersed throughout the entire pith cylinder. These are also relatively large, averaging .04 mm. in cross diameter, and having a definite epithelium layer with decidedly tangentially flattened cells.

Leaf. Canals are found above the veins and in the ground tissue and phloem of the midrib, those above the veins and in the midrib ground tissue averaging .03 mm. in breadth, while in the midrib phloem and average canal is .015 mm. in breadth. In the midrib there are four canals located below the three main vascular bundles, and the phloem of each vascular bundle may have several canals (Plate V, fig. 7).

Canals are found in both cortex and pith; those of the cortex are comparatively large, averaging .06 mm. in cross diameter (Plate IV, fig. 3). The canals of the pith are dispersed throughout the pith cylinder with an average cross diameter of .02 mm.

Helianthus salicifolius

Root. There are several tangentially flattened canals in the inner cortex which average .04 mm. in breadth. These do not have a well-defined epithelium.

Stem. There are numerous comparatively large canals in the cortex of the stem and several smaller canals in the pith. Those located in the pith occur near its periphery but have no particular position in relation to the protoxylem points. These average .015 mm. in breadth, and have from six to eight epithelium cells. The cortical canals average .04 mm. in cross diameter and are surrounded with from twenty to twenty-five rectangular epithelium cells.

Leaf. Canals occur in the midrib and above the veins, averaging .03 mm. in cross diameter. There are four canals located in the ground tissue of the midrib on the lower side of the vascular bundle (Plate V, fig. 5). These are conspicuous for their well-differentiated, triangular epithelium cells.

Rhizome. Numerous canals forming a broken cylinder are found within the inner cortex. The canals group themselves most noticeably radially opposite the phloem strands. These canals average .03 mm. in breadth, while canals occurring in the phloem average .05 in breadth.

Helianthus strumosus

Root. Numerous comparatively large tangentially flattened canals are found scattered within the inner cortex and phloem averaging .04 mm. in breadth (Plate I, fig. 4). The epithelium is not well-differentiated.

Stem. Canals occur in the cortex, phloem and pith. The canals of the cortex have no definite location in respect to the vascular system. An average canal here is .06 mm. in breadth and is usually somewhat tangentially flattened. These canals have a comparatively pronounced epithelium composed of rectangular cells (Plate II, fig. 5).

The phloem canals are relatively small, averaging .007 in breadth. They each have a definite epithelium.

The canals of the pith are also comparatively small, averaging .008 in cross diameter, but are numerous and scattered throughout the pith cylinder.

Leaf. Canals averaging .02 mm. in breadth occur above the veins. In the midrib the canals averaging .04 mm. across, are found in the ground tissue.

Rhizome. There are numerous canals within the cortical parenchyma and pith of the rhizome. Those of the cortex average .06 mm. in breadth, while in the pith the canals average .04 mm. in breadth. Canals averaging .015 mm. are often found in the phloem (Plate IV, fig. 4).

Helianthus trachelifolius

Root. Several canals averaging .015 mm. in breadth are found immediately opposite the phloem groups and each phloem group has from one to three canals.

Stem. Canals occur in the cortex, phloem and pith of the stem. Those in the cortex have no uniform arrangement in relation to the vascular system. They usually are slightly tangentially flattened and average .04 mm. in breadth. The epithelium is not as pronounced as in other species of this genus, though each canal does have a definite layer.

Canals of the phloem often occur two or three to a vascular bundle and average .007 mm. in breadth. There is a definite epithelium surrounding each canal.

In the pith the canals are also comparatively small, averaging .007 mm. in cross diameter. These canals are located in considerable numbers near the protoxylem points and their epithelium cells average four or five to a canal.

Leaf. In the midrib canals occur in the ground tissue and in the phloem of the vascular bundle. There are six canals within the ground tissue, averaging

.04 mm. in breadth. These have a definite arrangement in relation to the five vascular bundles. The canals in the phloem average .012 mm. in breadth. No canals are with the veins.

Rhizome. Numerous relatively small canals averaging .018 mm. in breadth are found in the cortex, pith and phloem.

Heliopsis scabra

Root. The canals are relatively inconspicuous, appearing as minute intercellular spaces filled with secretion. These average .01 mm. in cross diameter and are located in the inner cortex.

Stem. Canals averaging .01 mm. in cross diameter occur in cortex and pith. They lie in the cortical parenchyma between the large groups of primary hard bast and opposite a medullary ray in each case. The epithelium is composed of comparatively small cells which have in general the same shape as the surrounding cortical parenchyma cells.

In the pith the canals are similar in shape to those of the cortex and are only slightly smaller in size, averaging .008 mm. in cross diameter. These are close to the protoxylem points and alternate with them.

Leaf. There are canals below the larger veins and in the midrib. Those with the veins average .015 mm. in cross diameter. In the ground tissue of the midrib the six relatively small canals are dispersed with definite regularity in relation to the five vascular bundles. An average canal of the midrib is .02 mm. in cross diameter.

Iva ciliata

Root. No specialized secretory system occurs.

Stem. The stem of Iva ciliata has canals occurring in the cortex only. They are just outside the groups of primary hard bast. They average .04 mm. in cross diameter and have a definite epithelium layer composed of rectangular cells.

Leaf. The larger veins of the leaf blade have canals located above them averaging .015 mm. in breadth. A single canal averaging .015 mm. in breadth occurs above the vascular bundle of the midrib.

Lactuca pulchella

Root. There are numerous latex tubes occurring in radiating groups opposite the phloem.

Stem. Latex tubes are found in the cortex and phloem. Those of the cortex form a row lying in contact with each of the groups of primary hard bast (Plate III, fig. 4).

Leaf. Latex tubes occur in association with each of the veins and in the ground tissue of the midrib.

Lepachys columnifera

Root. Several large secreting pockets are located within the inner cortex. These average .06 mm. in breadth.

Stem. The stem of Lepachys columnifera has comparatively few and small canals. These occur in the pith only, near the protoxylem points. The average canal is .006 mm. in cross diameter and has relatively small epithelium cells.

Leaf. Canals averaging .015 mm. in breadth are found in the mesophyll and midrib.

Lepachys pinnata

Root. Canals appearing as ordinary intercellular spaces, because of the similarity of the epithelium cells to the cortical cells, are found in groups of three or four radially opposite the phloem. An average breadth is .04 mm.

Stem. Canals occur in both cortex and pith (Plate III, fig. 3). The canals in the cortex are not numerous and are opposite the groups of primary hard bast. They are comparatively obscure because they are tangentially flattened against the suberized endodermis. The average canal is .03 mm. in cross diameter. The epithelium layer is composed of relatively small cells.

Leaf. Two canals averaging .01 mm. in breadth occur in the ground tissue of the midrib, one above and one below the vascular bundle, and canals averaging .008 mm. in cross diameter occur above some of the main veins.

Rhizome. Tangentially flattened canals averaging .06 mm. in diameter occur in the inner cortex radially opposite each phloem group.

Liatris pycnostachya

Root. There is an average of three canals seen in cross section. These lie next to the endodermis and are radially opposite the phloem. An average canal is .03 mm. in breadth.

Stem. Canals found in the stem occur in the cortex only. They are comparatively inconspicuous, lying against and within an indentation of the undulated primary hard bast. The average canal is .015 mm. in breadth and is surrounded with from five to seven epithelium cells which are not well differentiated from the cortical parenchyma.

Leaf. Comparatively inconspicuous canals averaging .01 mm. in breadth occur laterally to the veins, while in the midrib there is a canal in the ground tissue on each side of the vascular bundle.

Corm. The corm has exceptionally large secretion pockets embedded in the parenchymatous tissue, a feature common in this genus (Plate IV, fig. 5). The pockets, averaging .9 mm. in cross diameter, are lined with several rows of tangentially flattened cells.

Liatris punctata

Root. The canals are similar in position and size to those of Liatris pycnostachya.

Stem. The canals of this species, averaging .02 mm. in breadth, occur in the cortex only, lying against the primary hard bast, and having about the same location and size as in the species aspera and pycnostachya.

Leaf. The location and size of the canals of this species are similar to those of Liatris pycnostachya.

Corm. Secretion pockets occur like those in Liatris pycnostachya.

Liatris aspera

Root. The canals have comparatively no difference in size and location from those in Liatris pycnostachya and punctata.

Stem. Canals are found in the cortex only and average .02 mm. in cross diameter. These have no well-differentiated epithelium layer.

Leaf. The canals in position and size resemble those of Liatris pycnostachya and punctata.

Corm. Secretion pockets occur like those in Liatris pycnostachya and punctata.

Mesadenia atriplicifolia

Root. Relatively large canals, averaging .12 mm. in cross diameter, one radially opposite each phloem group, are seen in cross section (Plate I, fig. 6). These are next to a suberized endodermis.

Stem. Canals with definite epithelium occur in both cortex and pith. The canals of the cortex are comparatively numerous and occur radially opposite a vascular bundle and close to the primary hard bast (Plate II, fig. 6). An average canal is .04 mm. in cross diameter.

Canals occurring at the periphery of the pith cylinder are like those of the cortex in size and shape.

Leaf. Canals occur in both the mesophyll and the midrib, averaging .03 mm. in cross diameter. In the midrib there are usually from two to four canals at the margins of the phloem and in the mesophyll canals occur singly above and below the veins.

Rhizome (tuberous). Comparatively large secretion pockets, averaging .08 mm. in cross diameter, are found within the cortex of the tuberous underground stem.

Pyrrhopappus carolinianus

Root. Numerous latex tubes are found in the cortex and phloem.

Stem. Latex tubes are in the cortex, phloem and pith. Those of the cortex are in contact with an endodermis, occurring more abundantly radially opposite the vascular bundles (Plate III, fig. 2). Those in the pith are in association with isolated groups of phloem.

Leaf. The latex tubes are beneath the veins in the midrib.

Senecio plattensis

Root. There is no specialized secretory system.

Stem. No specialized secretory system is present.

Leaf. No specialized secretory system is present.

Silphium speciosum

Root. The canals of young roots, averaging .15 mm. in breadth, form a broken cylinder around the stele, noticeably grouping opposite the phloem.

Stem. Canals occur in the cortical parenchyma opposite the medullary rays and in the pith (Plate III, fig. 6). In the cortex they are relatively large and conspicuous, averaging .08 mm. in breadth. Comparatively small epithelium cells form a single layer about each canal.

The canals of the pith occur in the periphery of the cylinder. They average .04 mm. in diameter and each is surrounded with a definite epithelium.

Leaf. Comparatively minute canals averaging .006 mm. in cross diameter occur above the veins. In the midrib the canals with triangular epithelium cells are interspersed between the vascular bundles.

Rhizome. Canals averaging .04 mm. in cross diameter and with a definite epithelium are found dispersed throughout the cortex, phloem and in the outer regions of the pith cylinder (Plate IV, fig. 2).

Silphium laciniatum

Root. Tangentially flattened canals, averaging .018 mm. in cross diameter, are quite numerous within the inner cortex. They have no well-differentiated epithelium and appear simply as intercellular spaces in contact with the endodermis.

Stem. In this species also the canals are found in the cortex and pith. Those of the cortex are dispersed throughout the parenchyma without definite relation to the vascular system. They are comparatively numerous and large, averaging .08 mm. in diameter. Each canal has a definite epithelium of rectangular cells.

In the pith the canals are located at the periphery of the cylinder and are much larger than the average of other species, being .08 mm. in breadth. There is a definite epithelium composed of comparatively large cells surrounding each canal.

Leaf. Outside the midrib, canals averaging .015 mm. in cross diameter are usually found one above and one below the larger veins (Plate V, fig. 4). Several canals averaging .03 mm. in diameter are located in the ground tissue surrounding the vascular system of the midrib (Plate V, fig. 2).

Rhizome. Numerous large tangentially-flattened secretion canals occur in the inner cortex averaging .06 mm. in cross diameter.

Solidago canadensis gilvocanescens

Root. Quite conspicuous canals with an average diameter of .06 mm. occur singly radially opposite each of the phloem groups and in contact with the suberized endodermis.

Stem. There are canals in the cortex and pith of this species. The cortical canals lie against the suberized endodermis and are tangentially flattened. The epithelium cells differ from the other cortical cells only by their relatively small size. An average canal is .04 mm. in cross diameter.

The canals in the pith are near the protoxylem points. They average .05 mm. in diameter and have a well-differentiated epithelium.

Leaf. All canals are comparatively large, averaging .04 mm. in diameter. They occur more often below than above the veins and those in the ground tissue of the midrib are located above and below the vascular bundle (Plate V, fig. 1).

Rhizome. Numerous large canals are found in the cortex and pith (Plate IV, fig. 1). The canals in the cortex lie next to a suberized endodermis and average .07 mm. in breadth. Those of the pith cylinder lie near the xylem and average .09 mm. in diameter.

Solidago Lindheimeriana

Root. The canals, ten in number, averaging .06 mm. in diameter, lie within the inner cortex and in association with a slightly suberized endodermis. The epithelium cells are tangentially flattened and relatively small. Each canal occurs radially opposite a phloem group.

Stem. The canals, found in the cortex only, are very inconspicuous and comparatively few. They are decidedly tangentially flattened against the suberized endodermis bounding the primary hard bast. The epithelium cells are comparatively small and tangentially flattened. An average canal is approximately .03 mm. in diameter radially and .06 mm. tangentially.

Leaf. The canals are comparatively inconspicuous, averaging .015 mm. in diameter. They occur singly below the veins and in the ground tissue of the midrib below the vascular bundle.

Rhizome. Numerous large canals averaging .1 mm. in breadth are found located within the inner cortex. The cells composing the epithele layer are quite tangentially flattened.

Solidago rigidiuscula

Root. A single canal lying in contact with a suberized endodermis and averaging .08 mm. in diameter is found opposite each phloem group (Plate I, fig. 1).

Stem. This species of Solidago also has canals in the cortex only, located against a suberized endodermis and radially opposite the vascular bundles. The average canal is .06 mm. in diameter. Also, there are canals associated with the suberized endodermis which surrounds each leaf trace as it traverses the cortex (Plate II, fig. 4). The epithelium is not well differentiated.

Leaf. A single canal averaging .06 mm. in diameter occurs beneath each of the three vascular bundles of the midrib. Beneath the larger veins is a canal averaging .03 mm. in diameter (Plate V, fig. 9).

Solidago rigida

Root. The canals have the same position as in the other species of Solidago but are smaller, averaging .04 mm. in breadth.

Stem. The canals of this species are very conspicuous because of their size, an average canal being .05 mm. in diameter. They are found in the cortex only, radially opposite the vascular bundles, with the epithelium in contact with the suberized endodermis.

Leaf. Canals averaging .05 mm. in diameter occur in the mesophyll and midrib. Those of the mesophyll occur singly below the larger veins. In the midrib a single canal is found in the ground tissue below each of the several vascular bundles.

Vernonia fasciculata

Root. The root has both a latex system and canals. It is typical of the above ground parts to have latex vessels only, but in the root a single canal, averaging .03 mm. in diameter, is found opposite each phloem group. The latex vessels are quite numerous in the cortex and phloem.

Stem. Latex vessels occur in the cortex and phloem, but there are no canals.

Leaf. Latex tubes occur in the ground tissue of the midrib and in association with the veins.

Rhizome. One to three canals, averaging .045 mm. in breadth, occur within the inner cortex radially opposite each of the primary phloem groups. Scattered throughout the phloem and cortex there are comparatively numerous latex tubes.

DISCUSSION

The Carduaceae, Ambrosiaceae and Cichoriaceae have been studied by a number of investigators from both anatomical and microchemical viewpoints. Those principally interested in the anatomical investigation of the three families, grouped as one family, the Compositae, were Trecul (1862), Vuillemin (1884), Van Tieghem (1885), and Col (1899). These investigators recognized certain characteristic features of the secretory systems of the Compositae. It was early observed by them that resin canals were widely distributed in the Carduaceae and Ambrosiaceae, while latex systems distinguished the Cichoriaceae. Supplementing these earlier anatomical studies, the research embodied in this paper presents a more complete record of a large number of species, especially in the Carduaceae.

Nearly all the species of Carduaceae and Ambrosiaceae that I have studied have resin canals present in roots, stems or leaves; however, *Senecio lobatus* has no specialized secretory system and *Aster drummondii* has canals only in the underground stem. Vuillemin (1884), however, says that *Senecio cordatus* has a specialized secretory system in the stem.

The roots of species of the Carduaceae present a much more uniform arrangement of the canals than do the stems, as was recognized by Col (1899). The majority of species, indicated in Table I, have canals; however, none were observed in *Amphiachyris dracunculoides, Aster azureus, Aster ericoides, Aster drummondii, Bidens frondosa, Euthamia camporum, Galinsoga ciliata, Grindelia squarrosa* and *Senecio plattensis.* The resin canals of the roots are found occurring singly or in groups radially opposite the primary phloem. Specialized secreting cells forming an epithelium are not present with the canals of the roots. As stated by Van Tieghem (1885), we do not recognize specialized secreting cells in the roots because each secreting cell has the same form and dimensions as the nonsecreting cells and each excretes its products into the canal which it borders. The comparatively small sizes of canals of some species indicated in Table I, and the lack of a well-defined epithelium, make it difficult at times to locate canals until after treating sections with Scarlet

R. The majority of species have relatively small intercellular-space canals in the younger roots, which occur in groups opposite the primary phloem and against the endodermis when this is present, often forming a broken cylinder about the stele. In the genus Solidago the canals are comparatively large (Table I), one occurring radially opposite each primary phloem group (Plate I, fig. 1). The presence of canals in the roots distant from the endodermis is not common, but *Helianthus strumosus* has canals within the phloem and scattered throughout the cortex (Plate I, fig. 4). In only one species of the Carduaceae, *Vernonia fasciculata,* have I found both resin canals and a latex system. Here the canals, averaging .03 mm. in cross diameter, occur singly radially opposite each of the primary phloem groups. The latex tubes in this species are dispersed throughout the cortex and some are found in the phloem.

In the roots of the species of Ambrosiaceae studied by me the canals in the endodermal region are comparable to those of the Carduaceae. *Ambrosia trifida* has canals in the phloem of the root also. No secretion system was observed in *Iva ciliata.*

In the Cichoriaceae a latex system is commonly found in the roots as well as in other parts. The latex tubes here are dispersed somewhat in the cortex, and mostly radially opposite the phloem, with a few in the phloem.

The species of Carduaceae, excepting *Senecio plattensis* and *Aster drummondii,* have canals in some part of the stem (Table II). The canals are relatively more common in the cortex, but sometimes they are found in the phloem and pith. Those species having canals in the cortex, as indicated in Table II, may be divided into two groups according to the location of the canals. When an endodermis is present the canals characteristically lie with their epithelium against the endodermis. This characterizes one group, while in the second group the canals are found dispersed in the cortex. Col (1889) says that in the stem the secretion canals are always endodermal in origin. Since my finding a large group of species in which the cortical canals are in no way associated with an endodermis Col's statement needs modification. Van Tieghem (1885) makes the statement that besides the endodermal secretion canals others occur in the cortex of stems beneath the epidermis, and in the parenchyma of the leaves, but he considers these to be rare. Species mentioned by Van Tieghem as having cortical canals not in association with an endodermis were *Kleninia neriifolia, Solidago limonifolia, Solidago sempervirens, Solidago laevigata* and *fuscata.*

I find *Solidago canadensis gilvocanescens, rigidiuscula* (Plate II, fig. 4), Lindheimeriana, and rigida to have cortical canals in contact with an endodermis. There are comparatively great differences in sizes of cortical canals in the various species. The sizes range from .008 mm. in cross diameter in *Heliopsis scabra* to .05 and .09 mm. in species of Helianthus, Solidago and Silphium (Table II). Position of the canals in relation to the vascular system, whether radially opposite or alternating with the phloem, varies with the different species, but this feature is not stable enough in the various species for their identification, although Solereder (1908) refers to it as being the most useful for systematic purposes (mostly as a generic character). The occurrence of well-defined epithelium cells is not consistent in the stem, but is more frequent there than in the root. Species of Helianthus exhibit strikingly well-differentiated secreting cells surrounding canals in the cortex (Plate II, fig. 5). Solereder (1908) says that the epithelium is probably of little value as a characteristic anatomical character, since resin canals devoid of epithelium and others provided with it occasionally occur side by side in the same plant (*Lasthenia glabrata, Cynaria corsica*) and that the canals without an epithelium do not always appear in all species of a genus (Cacalia, Senecio). I have observed *Mesadenia* (*Cacalia*) *atriplicifolia* (Plate II, fig. 6) to have canals in the cortex with an epithelium, while *Senecio plattensis* has no canals in the stem.

Those species having canals within the phloem of the stem are not numerous in the Carduaceae. *Helianthus rigidus* (Plate II, fig. 2), *strumosus* and *trachelifolius* were observed to have one or more canals in each phloem group, averaging .012 mm., .007 mm. and .007 mm in breadth, respectively.

In the Ambrosiaceae, *Ambrosia trifida* has one or more canals in each phloem group of the stem. Vuillemin (1884) considers it an exception to find canals located within the phloem of the stem.

Canals in the pith are found in a majority of the species of Carduaceae and Ambrosiaceae. These canals are smaller on an average than those of the cortex, as indicated in Table II, ranging from .009 mm. in *Ambrosia trifida* to .08 in *Silphium laciniatum*. The characteristic position of the canals in the pith is at the periphery where they usually occur opposite the protoxylem points in the various species (Plate III, fig. 3). Van Tieghem (1885) observed canals occurring either singly or several together in the pith of species of Ageratum, Carduus, Dahlia, Helianthus, Serratula, Solidago, and Spilanthes.

Of the Carduaceae I have found only one member, *Vernonia fasciculata,* to have a latex system in the stem. In this species the latex tubes are scattered within the inner cortex, phloem and more abundantly in the pith. Trecul (1862) speaks of *Vernonia gracalta* as having endodermal secretion canals, and Van Tieghem (1885) has found latex tubes in the phloem of this species.

The stems of species of Cichoriaceae have secretory systems in the form of latex tubes, a feature said by Van Tieghem (1885) and Col (1899) to be typical of the group. I find that these may occur in the cortex, phloem and pith. In the cortex they are most abundant within the inner cortex forming a broken-undulated cylinder (Plate III, fig. 4). In *Pyrrhopappus carolinianus,* there are latex tubes in association with isolated phloem groups within the pith (Plate III, fig. 2).

The perennial species of Carduaceae whose underground stems I have studied have either canals or secretion pockets as typical features. The rhizome may have canals located in the cortex, phloem and pith, as is true for the above-ground stem also (Plate IV, figs. 1-6). *Helianthus strumosus, Helianthus trachelifolius* and *Silphium speciosum* were of this type. The rhizomes of *Boltonia latisquama, Helianthus rigidus* and *Solidago canadensis gilvocanescens* have canals in the cortex and pith, while *Aster Drummondii, Mesadenia atriplicifolia, Euthamia camporum, Lepachys pinnata, Silphium laciniatum, Solidago Lindheimeriana* and *Vernonia fasciculata* have canals only in the cortex. The species of Liatris I have studied have corms and the secretion systems found here consist of large pockets scattered through the parenchymatous tissues (Plate IV, fig. 5). The underground stem of *Aster ericoides* did not seem to have a specialized secretory system.

The presence of a specialized secretion system in the leaves of the various species of Carduaceae and Ambrosiaceae is as typical of the two groups as is its presence in other parts, as indicated in Table III. *Senecio plattensis, Ambrosia elatior L.* and *Aster drummondii* are the only species I studied which did not have a specialized secretion system in some part of the leaf blade. In the leaves, canals may be found, one or more in the ground tissue of the midrib and in association with the veins of the mesophyll (Plate V, figs. 1-9). In only three species, *Ambroisia trifida, Helianthus rigidus* (Plate V, fig. 7), and *Helianthus trachelifolius,* were one or more canals found in the phloem of the midrib. The position of the canals of the leaf is a feature of taxonomic value affording the de-

markation of species into groups (see page 94). The usual position of the canals is above or below the veins. However, cases were found where the canals occur laterally to a vein. The approximate breadth range of the canals is from .003 mm. in *Bidens frondosa* to .09 mm. in *Erigeron canadensis*. Only one member of the Carduaceae, *Vernonia fasciculata*, was observed to have latex tubes in the leaf. These, as was characteristic of the canals, were closely associated with the veins of the mesophyll and midrib.

Latex tubes occur characteristically in the leaves of Cichoriaceae, where they are seen to follow the veins.

TABLE I.—Summarizing the cross diameter in mm. of the canals of roots

Actinomeris alternifolia	.015
Agoseris cuspidata	Latex system
Ambrosia elatior L.	.015
Ambrosia trifida	.015
Amphiachyris dracunculoides	....
Aster azureus	.012
Aster ericoides	....
Aster drummondii	....
Bidens frondosa	....
Bidens involucrata	.015
Boltonia latisquama	.015
Erigeron canadensis	.015
Erigeron ramosus	.018
Eupatorium altissimum	.02
Eupatorium urticaefolium	.015
Euthamia camporum	....
Galinsoga ciliata	....
Helianthus annuus	.04
Helianthus salicifolius	.04
Helianthus rigidus	.015
Helianthus strumosus	.05
Helianthus trachelifolius	.015
Heliopsis scabra	.01
Iva ciliata	....
Lactuca pulchella	Latex system
Lepachys columnifera	.05
Lepachys pinnata	.04
Liatris pycnostachya	.03
Liatris punctata	.03
Liatris aspera	.03
Mesadenia atriplicifolia	.12
Pyrrhopappus carolinianus	Latex system
Senecio plattensis	....
Silphium speciosum	.015
Silphium laciniatum	.015
Solidago canadensis gilvocanescens	.06
Solidago Lindheimeriana	.06
Solidago rigidiuscula	.08
Solidago rigida	.04
Vernonia fasciculata	(Also latex system) .03

TABLE II.—Summarizing the location and diameters in mm. of the specialized secretory systems in the stem

	Cortex	*Cortex**	*Phloem*	*Pith*
Actinomeris alternifolia	....	.015	....	....
Agoseris cuspidata	Latex system in all parts			
Ambrosia elatior L.	.015	....	....	....
Ambrosia trifida	.025	....	.007	.009
Aster azureus	....	....	....	....
Aster ericoides	....	.03	....	....
Aster drummondii	....	....	....	....
Bidens fondosa	.02	....	....	.01
Bidens involucrata	.01	....	....	.02
Boltonia latisquama	....	.045	....	....
Erigeron canadensis	....	.04	....	.012
Erigeron ramosus	....	.02	....	....
Eupatorium altissimum	.05	....	....	....
Eupatorium urticaefolium	....	.015	....	.015
Euthamia camporum	....	.03	....	.. .
Galinsoga ciliata	.006	....	....	....
Grindelia squarrosa	....	.03	....	....
Helianthus annuus	.08	....	....	.015
Helianthus salicifolius	.06	....	....	.015
Helianthus rigidus	.09	....	.012	.04
Helianthus strumosus	.06	....	.007	.008
Helianthus trachelifolius	.04	....	.007	.007
Heliopsis scabra	.008	....	....	.01
Iva ciliata	.04	....	....	....
Lactuca pulchella	Latex system in all parts			
Lepachys columnifera	....	....	....	.006
Lepachys pinnata	....	.03	....	.012
Liatris pycnostachya	.015	....	....	....
Liatris punctata	.02	....	....	....
Liatris aspera	.02	....	....	....
Mesadenia atriplicifolia	.04	....	....	.04
Pyrrhopappus carolinianus	Latex system in all parts			
Senecio plattensis	....	....	....	....
Silphium speciosum	.08	....	....	.04
Silphium laciniatum	.08	....	....	.08
Solidago canadensis gilvocanescens	....	.04	....	....
Solidago Lindheimeriana	....	.05	....	....
Solidago rigidiuscula	....	.06	....	....
Solidago rigida	....	.15	....	....
Vernonia fasciculata	Latex system in all parts			
Amphiachyris dracunculoides	....	.05	....	....

* Secretory system in the cortex with epithelium in contact with an endodermis.

TABLE III.—Summarizing the location and sizes in mm. of the specialized secretory systems of the leaf

	Midrib	*Midrib (phloem)*	*Mesophyll*
Actinomeris alternifolia	.008	....	....
Agoseris cuspidata	Latex system in all parts		
Ambrosia elatior L.	....	....	....
Ambrosia trifida	.02	.01	....
Amphiachyris dracunculoides	.05	....	.03
Aster azureus	.003	....	....
Aster ericoides	.02	....	.02
Aster drummondii	....	....	....
Bidens frondosa	.003	....	.003
Bidens involucrata	.005	....	.005
Boltonia latisquama	.04	....	.04
Erigeron canadensis	.09	....	.09
Erigeron ramosus	.015	....	.015
Eupatorium altissimum	.02	....	.02
Eupatorium urticaefolium	.01	....	.01
Euthamia camporum	.03	....	.06
Galinsoga ciliata	.008	....	.008
Grindelia squarrosa	.04	....	.04
Helianthus annuus	.04	....	.04
Helianthus salicifolius	.03	....	.03
Helianthus rigidus	.03	.015	.03
Helianthus strumosus	.04	....	.02
Helianthus trachelifolius	.04	.012	....
Heliopsis scabra	.02	....	.015
Iva ciliata	.015	....	.015
Lactuca pulchella	Latex system in all parts		
Lepachys columnifera	.015	....	.015
Lepachys pinnata	.01	....	.008
Liatris pycnostachya	.01	....	.01
Liatris punctata	.008	....	.01
Liatris aspera	.008	....	.01
Mesadenia atriplicifolia	.03	....	.03
Pyrrhopappus carolinianus	Latex system in all parts		
Senecio plattensis	....	....	....
Silphium speciosum	.006	....	.006
Silphium laciniatum	.03	....	.015
Solidago canadensis gilvocanescens	.04	....	.04
Solidago Lindheimeriana	.015	....	.015
Solidago rigidiuscula	.06	....	.03
Solidago rigida	.05	....	.05
Vernonia fasciculata	Latex system in all parts		

KEY TO SPECIES BASED ON LOCATION, SIZE AND CHARACTERISTICS OF EPITHELIAL CELLS OF THE INTERNAL SECRETORY SYSTEM

I. No specialized secretory system present.
Senecio plattensis.
Aster drummondii.

II. Secretory system present (canals) in roots, stems, and leaves.
A. In the stem the canals are present in cortex, phloem and pith.
1. Canals of the leaf in the mesophyll and midrib.
a. Canals in the phloem of the midrib.
Helianthus rigidus.
b. No canals in the phloem of the midrib.
Helianthus strumosus.
2. Canals of the leaf in the midrib only.
a. One canal in the ground tissue below the midrib vascular bundle.
Ambrosia trifida.
b. Six canals in the ground tissue around the midrib vascular bundles.
Helianthus trachelifolius.
B. In the stem the canals are present in the cortex and pith only.
1. Canals in the stem cortex with epithelium in contact with an endodermis.
a. Canals of the leaf with cavities not over .015 mm. in cross diameter.
(1) Midrib with two canals; one above and the other below the central vascular bundle.
Lepachys pinnata.
(2) Midrib with several canals; occurring above and below the central vascular bundle.
Eupatorium urticaefolium.
b. Canals of the leaf with cavities ranging from .04 mm. to .09 mm. in cross diameter.
(1) Canals of the mesophyll sometimes above, sometimes below the veins.
Solidago canadensis gilvocenescens.
(2) Canals of the mesophyll always below the veins.
Erigeron canadensis.
2. Canals in the stem cortex with epithelium cells apart from the endodermis.
a. Canals of the stem cortex averaging .08 mm. or over in cross diameter.
(1) Canals of the leaf midrib averaging .03 mm. in cross diameter.
Silphium speciosum.
(2) Canals of the leaf midrib averaging .04 mm. in cross diameter.
(a) Canals of the mesophyll occurring above and below the veins.
Silphium laciniatum.
(b) Canals of the mesophyll occurring above the veins only.
Hellianthus annuus.
b. Canals of the stem cortex averaging .06 mm. or less in cross diameter.
(1) Epithelium cells of the canals well defined; composed of rectangular cells.
Helianthus salicifolius.
(2) Epithelium cells of the canals not well defined nor rectangular.
(a) Epithelium cells of the canals containing a dark brown mass.
Bidens involucrata.
(b) Epithelium cells not as above.
1. Canals of the stem cortex average .008 mm. in cross diameter.
Heliopsis scabra.
2. Canals of the stem cortex average .04 mm. in cross diameter.
Mesadenia atriplicifolia.
C. In the stems the canals are present in the cortex only.
1. Canals of the stem not in contact with an endodermis.
a. Underground stem in the form of a corm with large secretion pockets.
Liatris aspera.
Liatris pycnostachya.
Liatris punctata.

b. Underground stem not in the form of a corm.
Eupatorium altissimum.
Actinomeris alternifolia.
2. Canals of the stem cortex with epithelium in contact with an endodermis.
a. Canals of the stem averaging .05 mm. or over in cross diameter.
Solidago Lindheimeriana.
Solidago rigidiuscula.
Solidago rigida.
Boltonia latisquama.
b. Canals of the stem averaging .04 mm. or less in cross diameter.
Erigeron ramosus.
D. In the stem the canals are present in the pith only.
Lepachys columnifera.
III. Canals present in stems and leaves only.
A. Canals in stem cortex with epithelium cells in contact with an endodermis.
Aster ericoides.
Amphiachyris dracunculoides.
Euthamia camporum.
Grindelia squarrosa.
B. Canals in the stem cortex not having epithelium cells in contact with an endodermis.
1. Canals in both cortex and pith.
Bidens frondosa.
2. Canals in cortex only.
Galinsoga ciliata.
Iva ciliata.
IV. Canals present in the roots and stems only.
Ambrosia eliatior L.
V. Canals present in the roots and leaves only.
Aster azureus.
VI. Canals in the roots only; latex system in other parts as well as in the roots.
Vernonia fasciculata.
VII. Only a latex system present.
Agoseris cuspidata.
Lactuca pulchella.
Pyrrhopappus carolinianus.

THE OCCURRENCE AND IDENTIFICATION OF SECRETIONS STAINED RED WITH SCARLET R

Secretions which stain red with Scarlet R are found in abundance in the Carduaceae, Ambrosiaceae and Cichoriaceae. Sections taken from various parts of the plant show, as a rule, numerous globules of these secretions dispersed in the parenchymatous tissues, and in masses and specialized secretory systems. In many species which have large-cavitied canals the secretion exudes easily from the fresh-cut surfaces.

The tissue of the plant which contains the greatest number of dispersed globules is the mesophyll of the leaf. Cross sections of leaves of such species as *Solidago canadensis gilvocanescens* (Plate V, fig. 1), *Amphiachyris dracunculoides* (Plate V, fig. 3), *Mesadenia atriplicifolia* and *Boltonia latisquama* treated with Scarlet R present a striking appearance due to the great quantity of dispersed globules.

The quantity of secretion in the mesophyll varies among the species observed, but in each some secretion was present. The following table gives a comparison of the species based upon the relative amounts of dispersed globules within the mesophyll of the leaf:

TABLE IV.—The symbol (†) indicates comparative amounts of secretion in the leaves

Agoseris cuspidata	††
Ambrosia elatior L.	†
Ambrosia trifida	†
Amphiachyris dracunculoides	††††
Aster azureus	†††
Aster ericoides	†††
Aster drummondii	†††
Bidens frondosa	†
Bidens involucrata	†
Boltonia latisquama	††††
Erigeron canadensis	††
Erigeron ramosus	††
Eupatorium altissimum	††
Eupatorium urticaefolium	††
Euthamia camporum	††††
Galinsoga ciliata	†
Grindelia squarrosa	††††
Helianthus annuus	†††
Helianthus salicifolius	†††
Helianthus rigidus	†††
Helianthus strumosus	†††
Helianthus trachelifolius	†††
Heliopsis scabra	†††
Iva ciliata	†††
Lactuca pulchella	††
Lepachys columnifera	††
Lepachys pinnata	††
Liatris pycnostachya	††††
Liatris punctata	††††
Liatris aspera	††††
Mesadenia atriplicifolia	††††
Pyrrhopappus carolinianus	††
Senecio plattensis	††
Silphium speciosum	††††
Silphium laciniatum	††††
Solidago canadensis gilvocanescens	†††††
Solidago Lindheimeriana	††††
Solidago rigida	††††
Vernonia fasciculata	†††
Actinomeris alternifolia	†††

The secretions of the above- and below-ground stems are principally in the canals, but small globules are found dispersed in all of the living tissues. If the stem has chlorenchyma the globules are abundant as in the leaf. The frequency and size of the canals in the stems of the different species indicate the relative amounts of secretion.

Roots have the least amount of the secretion of any of the plant parts. Certain species are outstanding for their large canals and abundant secretions, such as species of Solidago and Helianthus.

Evidence of the nature of the secreted materials within the various parts of the plants has been sought for by various microchemical tests. The microchemical tests have been found altogether satisfactory on account of the relatively small size of the globules present.

Chemically different substances have been demonstrated: fats, ethereal oils, resins and caoutchouc, all staining red with Scarlet R. A fat is an ester of glycerol with one or more of the higher fatty acids. Essential, or ethereal, oils consist of a mixture of hydrocarbons, mostly terpenes, together with alcohols such as terpeneol and camphors. The chemistry of resins is not nearly as well known as that of fats and ethereal oils. Resin, according to Tschirch (1934), is neither a chemical nor a physical term applied to any specific substance, but is one of common usage, as is the term tannin, being applied to a group of similar substances. Weisner (1927) considers resins as an excreted product resulting from the plant's metabolism. Chemically, resins are considered very complex substances formed by a combination of linkages of various kinds, the majority of which contain phenol groups, aliphatic acids, aldehydes and terpenes.

The microchemical tests have been carried on only with fresh materials. After using Scarlet R for the differentiation of the contents occurring in the canals and other parts, relative solubility tests were employed. These alone may not be considered sufficient to distinguish between fats, resins, ethereal oils and caoutchouc, but do serve for a major part in making this distinction possible. The solvents used were alchohol, acetone, chloroform, acetic acid, carbon disulphide and benzene. Any of these solvents may dissolve various resins. Alcohol is a solvent for but very few fats, while chloroform and carbon disulphide are well-known fat solvents. Caoutchouc is insoluble in acetone but soluble in benzene. Wiesner (1927) speaks of "Harze" as being distinguished from caoutchouc and guttapercha through the fact that resin and resin-like materials are soluble in alcohol and acetone while the other two are insoluble. For further distinction between fats and resins I have used the saponification test for fats. Moenike (1924) considered this to be the most critical tests for fats. For this test I used a concentrated so-

lution of KOH in methyl alcohol which has been found to produce myelin bodies within five to ten minutes with any of the more common plant oils, such as castor bean seed oil, cocoanut oil, palm oil and others. This reagent taken from Tunmann (1913) is superior to other saponification tests in the speed of the reaction. This test has been carried on with sections first treated with Scarlet R to increase the visibility of the secretions and also with exuded "juice" carrying dispersed globules which were stained red with Scarlet R. Ethereal oils have been tested for, in addition to the solubility test of acetic acid, by using microdistillation. These tests, in conjunction with the tabulated solubility tests, point to the fact that the secretions are resinous in their chemical nature. The presence of caoutchouc, which has been found to occur in a number of the examined plants, was made certain by observing the solubility. That is, when the substance was stained red with Scarlet R and was non-saponifiable, but was insoluble in acetone, but soluble in benzene, chloroform, alcohol or carbon disulphide, it was considered to be caoutchouc. A complete list of the plants with the solubility of their secretion follows:

TABLE V.—Showing solubility of secretions which stain red with scarlet R

	Acetone.	Benzene.	Chloroform.	Alcohol.	Carbon disulphide.	Acetic acid.
Agoseris cuspidata:						
(globules)	sol.	sol.	sol.	sol.	sol.	sol.
(latex)	insol.	sol.	sol.	insol.	sol.	insol.
Ambrosia trifida	sol.	insol.	sol.	insol.	sol.	insol.
Amphiachyris dracunculoides	insol.	sol.	insol.	insol.	sol.	insol.
Aster azureus	insol.	sol.	insol.	insol.	insol.	insol.
Aster drummondii	insol.	sol.	insol.	sol.	sol.	insol.
Aster ericoides	insol.	sol.	insol.	insol.	insol.	insol.
Bidens frondosa	insol.	insol.	insol.	sol.	insol.	insol.
Bidens involucrata	insol.	insol.	insol.	sol.	insol.	insol.
Boltonia latisquama	insol.	sol.	insol.	insol.	sol.	insol.
Erigeron ramosus	insol.	sol.	sol.	insol.	sol.	insol.
Erigeron canadensis	insol.	insol.	sol.	insol.	sol.	insol.
Eupatorium altissimum	sol.	sol.	p. sol.	sol.	p. sol.	insol.
Eupatorium urticaefolium	sol.	sol.	sol.	sol.	sol.	insol.
Euthamia camporum	sol.	sol.	sol.	sol.	sol.	insol.
Grindelia squarrosa	sol.	insol.	sol.	sol.	sol.	insol.
Helianthus annuus	sol.	insol.	sol.	sol.	sol.	insol.
Helianthus salicifolius	insol.	sol.	insol.	insol.	sol.	insol.
Helianthus strumosus	sol.	sol.	p. sol.	sol.	sol.	insol.
Helianthus trachelifolius	sol.	insol.	sol.	sol.	sol.	sol.
Heliopsis scabra	sol.	sol.	sol.	sol.	sol.	insol.
Iva ciliata	insol.	insol.	sol.	insol.	sol.	insol.
Lactuca pulchella (globules)	sol.	insol.	sol.	sol.	sol.	sol.
Lactucca pulchella (latex)	insol.	sol.	sol.	insol.	sol.	insol.
Lepachys pinnata	insol.	sol.	p. sol.	insol.	sol.	insol.
Liatris pycnostachya	sol.	insol.	p. sol.	insol.	insol.	insol.
Liatris aspera	sol.	insol.	sol.	sol.	sol.	sol.
Mesadenia atriplicifolia	insol.	sol.	insol.	insol.	sol.	insol.
Pyrrhopappus carolinianus (globules)	insol.	sol.	sol.	sol.	sol.	insol.
Pyrrhopappus carolinianus (latex)	sol.	insol.	sol.	sol.	sol.	sol.
Senecio plattensis	sol.	insol.	sol.	insol.	p. sol.	insol.
Silphium speciosum	sol.	insol.	insol.	insol.	sol.	insol.
Silphium laciniatum	sol.	insol.	sol.	sol.	insol.	insol.
Solidago canadensis gilvocanescens	insol.	sol.	p. sol.	insol.	sol.	insol.
Solidago Lindheimeriana	insol.	sol.	p. sol.	insol.	sol.	insol.
Solidago rigidiuscula	insol.	sol.	p. sol.	insol.	sol.	insol.
Vernonia fasciculata	sol.	sol.	insol.	sol.	insol.	sol.

TABLE VI.—Chemical nature of secretion based upon solubility tests

Agoseris cuspidata (globules)	Resinous
(latex)	Caoutchouc
Ambrosia trifida	Resinous
Amphiachyris dracunculoides	Caoutchouc
Aster azureus	Caoutchouc
Aster drummondii	Caoutchouc
Aster ericoides	Caoutchouc
Bidens frondosa	Resinous
Bidens involucrata	Resinous
Boltonia latisquama	Caoutchouc
Erigeron canadensis	Resinous
Erigeron ramosus	Caoutchouc
Eupatorium altissimum	Resinous
Eupatorium urticaefolium	Resinous
Euthamia camporum	Resinous
Grindelia squarrosa	Resinous
Helianthus annuus	Resinous
Helianthus salicifolius	Caoutchouc
Helianthus strumosus	Resinous
Helianthus trachelifolius	Resinous
Heliopsis scabra	Resinous
Iva ciliata	Resinous
Lactuca pulchella (globules)	Resinous
(latex)	Caoutchouc
Lepachys pinnata	Caoutchouc
Liatris aspera	Resinous
Liatris pycnostachya	Resinous
Mesadenia atriplicifolia	Caoutchouc
Pyrrhopappus carolinianus	Resinous
Senecio plattensis	Resinous
Silphium speciosum	Resinous
Silphium laciniatum	Resinous
Solidago canadensis gilvocanescens	Caoutchouc
Solidago rigidiuscula	Caoutchouc
Solidago rigida	Caoutchouc
Vernonia fasciculata	Resinous

In following the development of a number of species in their primary permanent tissue stages it has been observed that the majority of the young plants do not contain the dispersed globules in their parenchymatous tissues typical of the more mature plants. However, the canals did contain secretion during the formation of the primary meristematic tissues.

Considerable difference in time of formation of the dispersed globules so typical of the mature leaf mesophyll has been noted for several species. For this purpose plants of *Silphium laciniatum* and *speciosum*, *Chrysanthemum leucanthemum* and *Helianthus strumosus* were grown in the greenhouse. The plant of *Chrysanthemum leucanthemum* when brought in from the field had a large group of basal leaves, but these contained no globules. Formation of globules occurred soon after the plant had produced its first flowers. The plant of *Helianthus strumosus* grew to a height of five feet and

was ready to produce flowers when globules began to appear in the leaf mesophyll. *Silphium laciniatum* produced a number of large basal leaves without having the dispersed globules until after three weeks. *Silphium speciosum* grew approximately two feet tall before globules were observed. In each of the latter two cases globule formation occurred considerably ahead of flower formation.

Similar observations were made of these species when they grew in the field which gave comparable results.

Possible functions of these secretions in the plant are not evident. To consider that they actually serve as a reserve substance later used in the plant's metabolism might seem justified by the large quantities formed. However, dead parts, especially the leaves of certain species, when examined microchemically exhibit an abundance of the secretion remaining. Species showing this were *Solidago canadensis gilvocanescens*, *Boltona latisquama*, *Helianthus salicifolius*, *Solidago rigida*, *Euthamia camporum*, *Mesadenia atriplicifolia*, *Liatris aspera* and *pycnostachya*. Lloyd (1932), in discussing possible uses of caoutchouc to the plant, says that whether the hydrocarbon in question is, in the case of the guayule, actually a reserve substance and is actually made use of in metabolism requires proof which has not yet appeared. That the presence of the globules in the leaves might serve in drought resistance has been suggested by Transeau (1904). Lloyd (1932) says that the view which has been advanced from time to time, that caoutchouc in the guayule confers on the plant some ability to withstand drought, has no convincing evidence.

In an attempt to determine if the globules would disappear when the plant was starved, indicating their being used in metabolism, young and old plants were brought in and placed in the dark. The young plants were taken from the field just after the first evident globule formation. The globules remained in the older plants but disappeared from the younger plants. Plants showing this were *Mesadenia atriplicifolia*, *Liatris aspera*, *Helianthus strumosus*, *rigidus* and *Solidago canadensis gilvocanescens*.

PLATE I

Photomicrographs of root cross sections. (× 76)

1. Solidago rigidiuscula.
2. Ambrosia trifida.
3. Actinomeris alternifolia.
4. Helianthus strumosus.
5. Silphium speciosum (old root).
6. Mesadenia atriplicifolia.

PLATE I

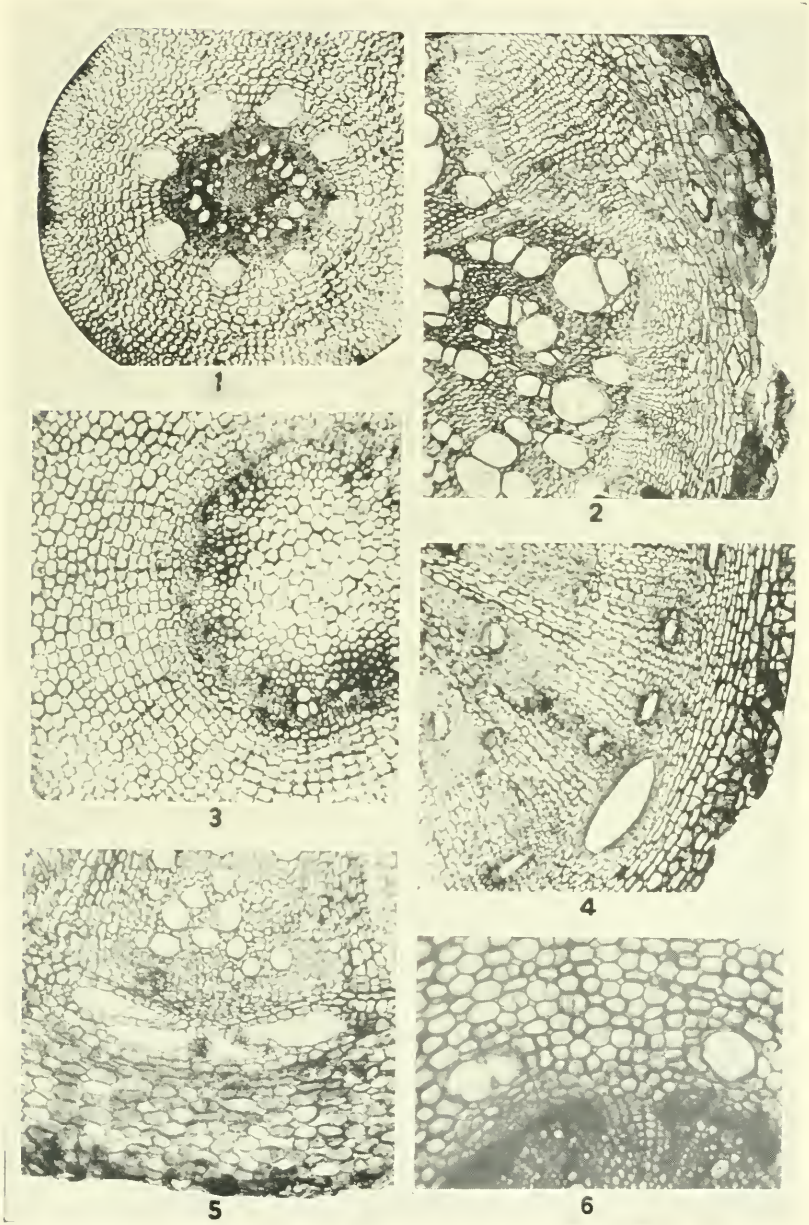


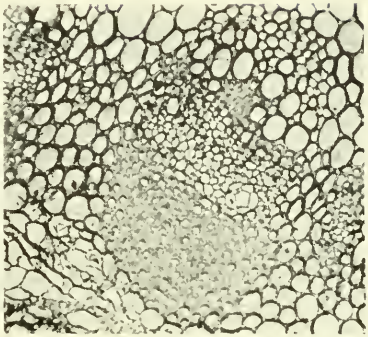
PLATE II

Photomicrographs of stem cross sections

1. Bidens frondosa × 76.
2. Helianthus rigidus × 150.
3. Helianthus rigidus × 76.
4. Solidago rigidiuscula × 76.
5. Helianthus strumosus × 76.
6. Mesadenia atriplicifolia × 76.

PLATE II

1



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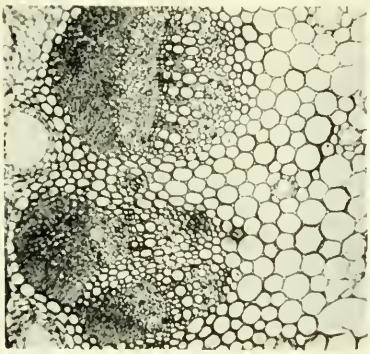

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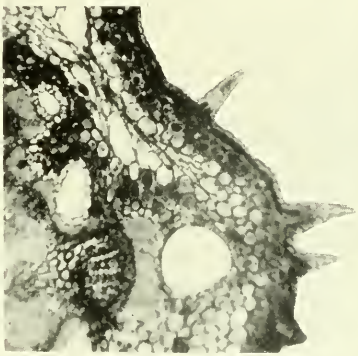

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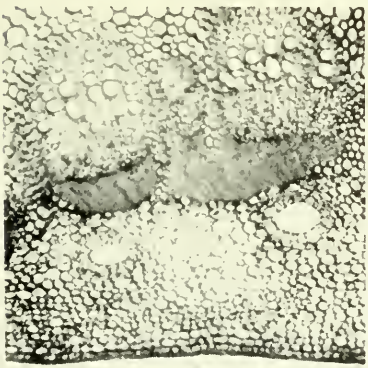

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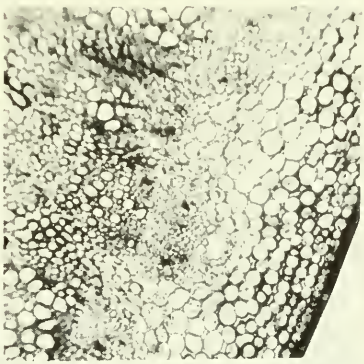


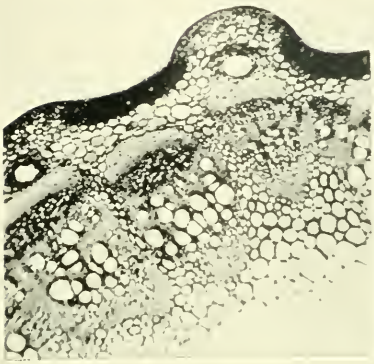
6

PLATE III

Photomicrographs of stem cross sections. (× 76)

1. Erigeron canadensis
2. Pyrrhopappus carolinianus.
3. Lepachus pinnata.
4. Lactuca pulchella.
5. Ambrosia elatior L.
6. Silphium speciosum

PLATE III



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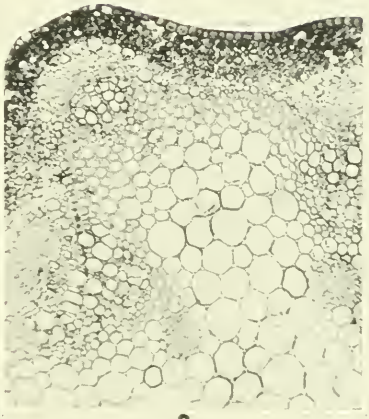

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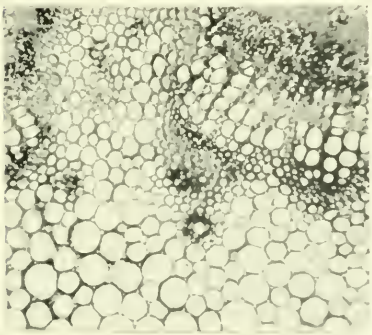

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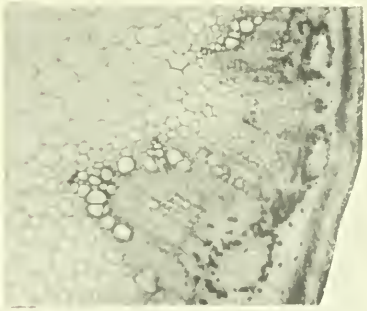

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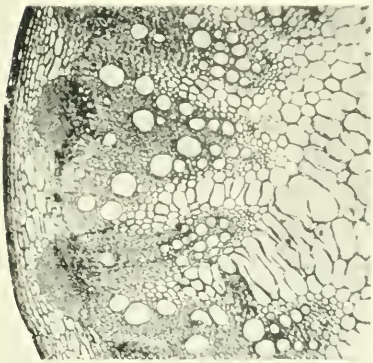

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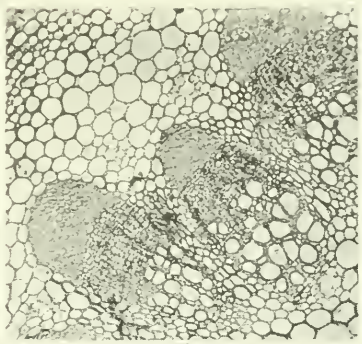


6

PLATE IV

Photomicrographs of rhizome cross sections. (× 76)

1. Solidago canadensis gilvocanescens.
2. Silphium speciosum.
3. Helianthus rigidus.
4. Helianthus strumosus.
5. Liatris pycnostachya (corm).
6. Actinomeris alternifolia.

PLATE IV

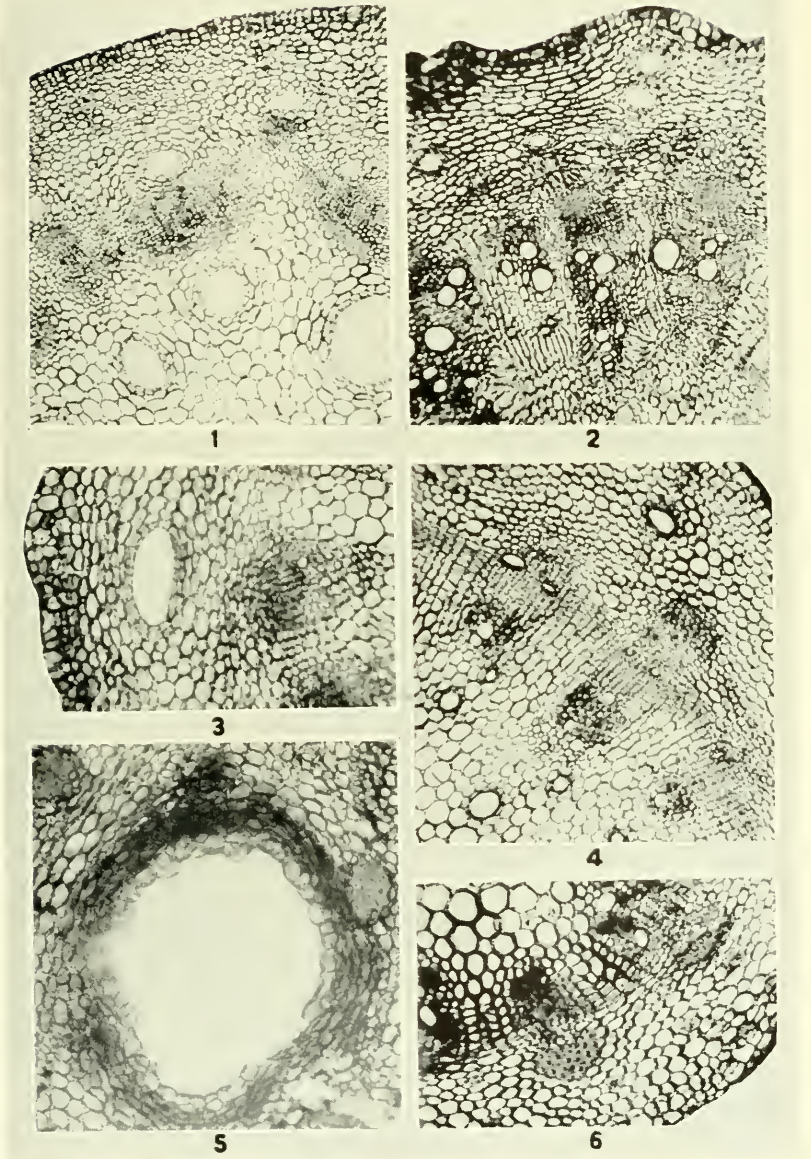
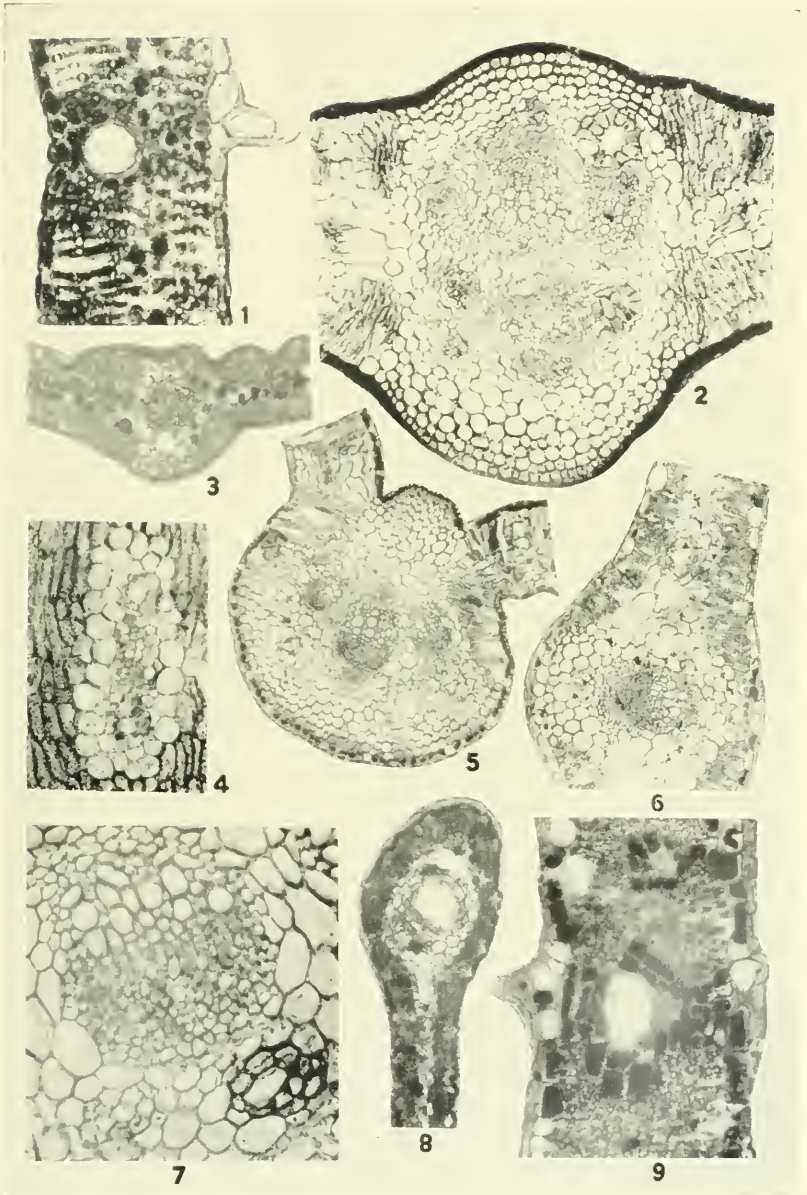


PLATE V

Photomicrographs of leaf cross sections

1. Solidago canadensis gilvocanescens × 76
2. Silphium laciniatum × 76.
3. Amphiachyris dracunculoides × 76.
4. Silphium laciniatum × 150.
5. Helianthus salicifolius × 76.
6. Boltonia latisquama × 76.
7. Helianthus rigidus × 76.
8. Erigeron canadensis × 76.
9. Solidago rigidiuscula × 76.

PLATE V



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The Genus Taphrina. I: An Annotated Bibliography

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ABSTRACT: A critical review is presented of the important literature on the genus Taphrina (including Ascomyces, Exoascus, Magnusiella), from the time of Fries (1815) to the present. Many references containing merely information as to distribution of various species have been omitted, as well as some papers of purely practical nature on disease control.

NO monographic treatment of the genus Taphrina is available to the average worker later than that of Giesenhagen in 1901. Many species have been described since then. Jaczewski published, in 1926, a key to known species with descriptions. His paper is in Russian and is not easily obtainable. Otherwise it would serve well as a means of determining species. A complete list of known species is also given by Laubert in the latest edition of Sorauer's Handbuch der Pflanzenkrankheiten. This list, however, gives descriptions of only the most important species, and with rare ones the investigator is left with only the name of the parasite and the host.

It is proposed to remedy this lack by the publication of a descriptive list of valid species of Taphrina (including Ascomyces, Exoascus, Taphrina, and Magnusiella).

Preliminary to this it seems desirable to present a review of the important literature on the genus. This literature is considerable, and much of it is contained in papers not easily available. The review here presented is intended to summarize all important findings of previous investigators and to enable anyone interested in the literature of Taphrina to ascertain readily where the particular information he desires may be found.

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The arrangement of this review in the form of an annotated bibliography is considered convenient for consultation, as well as valuable in furnishing a strictly chronological treatment of the literature.

Many papers have been consulted whose titles are not here presented. Notes of the occurrence of particular species in new localities have, for the most part, not been included, and of the large body of literature of peach-leaf curl only those papers have been cited which seem significant from a mycological point of view.

An attempt has been made to follow the best modern usage in the citation of authors' names in connection with the names of host species. In the original articles authors' names are frequently omitted.

All the papers listed have been consulted in the original, and it is believed that the abstracts of their contents given below are essentially correct.

1. FRIES, E. Observationes Mycologicae. *1:* 217. 1815.

Describes the genus Taphria, and the species *Taphria populina aurea* on leaves of *Populus nigra* L.

2. FRIES, E. Observationes Mycologicae. *2:* 378. 1818.

Again describes the above-named species and figures it (Pl. VIII, fig. 3).

3. FRIES, E. Systema orbis terrarum vegetabilis. Pars I. Plantae Homonemeae. Lund. 1825. P. 317.

Changes the genus name to Taphrina since Taphria has already been employed as the genus name of an insect.

4. FRIES, E. Systema mycologicum. *3:* 520. 1832.

Changes name of *Taphrina aurea,* on leaves of *Populus nigra,* to *T. populina.* Also lists (p. 30, No. 520) *Taphrina alnea* Schmidt on leaves of *Alnus glutinosa* Medic. The latter fungus, not being mentioned in later literature, was probably an Erineum.

5. ZOLLINGER, H. Observationes phytographicae, praecipue genera et species nova nonnulla respicientes. Natur-et Geneeskundig Archief voor Neerlands Indie *1:* 372-405; *2:* 1-19, 200-273, 563-587; *3:* 51-92. Abs. in Flora *5:* 300. 1847.

Describes a new species *Taphrina cissi* Zoll. on *Cissus varius* (?). This species seems uncertain and has not been recognized by most of the later writers.

6. DESMAZIERES, J. B. H. J. Seizième notice sur les plantes cryptogames recemment decouvertes en France. Ann. d. Sci. Nat. 3e ser. Botanique. *10:* 342-361. 1848.

Describes the new genus Ascomyces Mont. and Desmaz., characterized by ascus-like sporangia on the surface of the host leaf. Also the new species *Ascomyces caerulescens* Mont. and Desmaz. on leaves of *Quercus coccifera* L.

The new genus is not clearly differentiated from the existing genus, Taphrina. In the species description, however, it is stated that the sporangia constitute the whole fungus, *i.e.*: mycelium is absent.

The spelling of the species name "caerulescens" is to be noted. This spelling was followed by Robinson (55) and others. Some later authors have used the spelling "coerulescens." In this paper the original spelling is restored.

7. FRIES, E. Summa vegetabilium Scandinaviae. Sectio Posterior. Upsala. 1849.

On page 518 gives a description of the genus Taphrina, naming one species, *Taphrina populina* Fr. as occurring in Sweden.

8. BERKELEY, M. J. Jour. Roy. Hort. Soc. London *9:* 48. 1854. Describes a new species, *Ascomyces bullatus* Berk. on pear leaves.

9. BERKELEY, M. J. Introduction to Cryptogamic Botany. London. 1857.

Figures (p. 284, fig. 66c) without description, *Ascomyces bullatus* Berk. and describes a deformation of peach leaves as due to another species of this genus.

10. BERKELEY, M. J. Outlines of British Fungology. 1860.

Describes (p. 376) briefly the genus Ascomyces and lists four species occurring in England: 1. *Ascomyces bullatus* Berk. on pear leaves, 2. *A. deformans* Berk. on peach leaves, "causing one form of blister," 3. *A. tricntalis* Berk. on leaves of *Tilia europaea* L., 4. *A. juglandis* Berk. on walnut leaves.

The two last-named forms did not prove subsequently to be members of the Taphrinaceae. *A. juglandis* is definitely excluded by Giesenhagen (94).

Figures (Plate 1, fig. 9) *Ascosporium deformans* (sic).

11. FUCKEL, L. Enumeratio fungorum Nassoviae. Jahrb. d. Ver. f. Naturk. in Herzogt. Nassau *15:* 1-123. 1860.

Describes (p. 29, No. 189) the genus Exoascus, and the species *E. pruni* Fkl. on fruits of *Prunus domestica* L. and *Prunus spinosa* L. Also figures (fig. 26) this species. Lists (p. 30, No. 200) *Taphrina alnea* Schmidt on leaves of *Alnus glutinosa* Medic.

12. WESTENDORP, G. D. Sur quelques cryptogames nouvelles ou inédites pour la flore belge, septième notice. Bull. d. l. Acad. Roy. d. Sci. d. Lettr. et. d. Beaux-arts d. belgique. 2e ser. *11:* 644-660. 1861.

Describes (p. 655) *Ascomyces tosquinetii* West. on leaves of *Alnus glutinosa* Medic.

13. BARY, A. de. Beiträge zur Morphologie und Physiologie der Pilze. II. Exoascus pruni und die taschen oder narren der pflaumenbäume. Abhandl. d. Senkenberg. Naturforsch. Ges. *5:* 169-191. 1865.

An account of *Exoascus pruni* Fkl. on fruits of *Prunus domestica* L., *P. spinosa* L., and *P. padus* L. In spite of smaller asci of the form on *P. padus*

refers it to the same species. Gives a full account of the pathological morphology and histology of the diseased fruit. Describes ejection of spores, and budding of ejected spores in water, sugar solution, and yeast decoction. The "sprossen" derived from ascospores by budding do not cause alcoholic fermentation. The "sprossen" are believed to give rise (in some manner) to new infections.

14. TULASNE, L. R. Super Friesiano Taphrinarum genere, et Acyptolospore Mazeriana, accedente Ustilaginis marinae. Ann. d. Sci. Nat. 5e Ser. Botanique. *5:* 122-136. 1866.

Revises Fries' description of the genus Taphrina and includes the following species (the author-citation following each species name is that which would result from this revision):

I. Taphrinae polysporae
   1. *Taphrina aurea* Fr.
   2. *Taphrina caerulescens* (Mont. et Desm.) Tul.

II. Taphrinae octosporae or Exoasci
   3. *Taphrina bullata* (Berk.) Tul.
   4. *Taphrina deformans* (Berk.) Tul.
   5. *Taphrina pruni* (Fkl.) Tul.
   6. *Taphrina alnitorqua* (Westend.) Tul.

Ascomyces and Exoascus thus become synonyms of Taphrina, although no statement is made that forms previously described under Ascomyces are known to possess mycelium. A quite unwarranted procedure is the change of the specific name of the fungus described by Westendorp as *Ascomyces tosquinetii* (Westend.) Tul. It is to be noted that the species name *tosquinetii* is later restored by Sadebeck (73).

15. FUCKEL, L. Symbolae Mycologicae. Beiträge zur kenntnis der rheinischen pilze. Jahrb. d. Nassau. Ver. fur Naturk. *23* & *24:* 1-459. 1869 and 1870.

Refuses (p. 252) to accept the genus Taphrina as revised by Tulasne, and recognizes two genera, Ascomyces with many-spored asci, and Exoascus with eight-spored asci.

Fuckel here is guilty of two errors: First in refusing to concede the priority of Taphrina over Exoascus; second, in ignoring the character on which Desmazières erected the genus Ascomyces *i. e.:* the absence of mycelium.

Fuckel's species are as follows:

1. *Exoascus pruni* Fkl. on fruits of *Prunus domestica* L., *P. spinosa* L., and *P. padus* L.
2. *E. deformans* (Berk.) Fkl.
   a. forma *persicae* on leaves of *Persica vulgaris* Mill. (*Prunus persica* [L.] Stokes.)
   b. forma *cerasi* on leaves of *Cerasus avium* (*Prunus avium* L.)
3. *E. alni* (de By.) Fkl. on leaves of *Alnus glutinosa* Medic.

This last-named species Fuckel describes as new, calling it *Exoascus alni* de Bary in litt, but recognizes its previous description by Westendorp since he gives as synonyms *Taphrina tosquinetii* Westend. and *T. alnitorqua* Tul. According to modern standards of nomenclature this fungus must be called *Taphrina tosquinetii* (Westend.) Tul.

16. KÜHN, J. *Exoascus alnitorqua* var. *alni-incanae* J. Kühn on fruits of *Alnus incana* Willd. In Rabenhorst, L. G. Winter, and O. Pazschke. Fungi Europaei. Cent. *22,* No. 1616.

Kühn here distinguishes for the first time the fungus on carpels of alder which later became recognized as a separate species, *T. alni-incanae* (Kühn) Magn.

17. FUCKEL, L. Symbolae Mycologicae. Beiträge zur kenntnis der rheinischen pilze. Zweiter Nachtrag. Jahrb. d. Nassau. Ver. f. Naturk. *27* and *28:* 1-99. 1873 and 1874.

Under the genus Exoascus describes a new variety, *E. bullatus* (Berk) Fkl. var. *crataegi* Fkl. on leaves of *Crataegus oxyacantha* L., and two new species, *E. ulmi* Fkl. on under sides of leaves of *Ulmus campestris* L. and *E. betulae* Fkl. on leaves of *Betula alba.* L.

18. THÜMEN, F. VON. Eine neue Protomyces species. Hedwigia *13:* 97-98. 1874.

This note concerning another fungus mentions the collection of a form on leaves of *Populus pyramidalis* (*P. alba* L. var. *pyramidalis* Bunge) and *P. nigra L.* closely resembling *Exoascus alni* de By. and here named without description *E. populi* Thm.

19. MAGNUS, P. Kurze notiz über Protomyces pachydermus. Hedwigia *13:* 113-114. 1874.

States that the fungus called *Exoascus populi* by von Thümen is *Taphrina aurea* Fr.

20. THÜMEN, F. VON. Nochmals Protomyces pachydermus. Hedwigia *13:* 149. 1874.

Objects that Magnus has not seen his *Exoascus populi* nor a description of it, and that even if it proves identical with *Taphrina aurea* Fr. the genus name Taphrina has not been recognized by most mycologists and is unsuitable for a fungus, having been previously used for "Pili degenerati." Prefers to recognize the genus Exoascus for eight-spored forms and Ascomyces for many-spored forms, thus following Fuckel.

21. MAGNUS, P. Ascomyces Tosquinetii Westendorp. Hedwigia *13:* 135-136. 1874.

Decides that this fungus has no mycelium, each ascus, a plant by itself, arising in and growing out from an epidermal cell of the host. The genus Ascomyces is quite distinct from Exoascus in which the asci arise from a subcuticular hymenium. *Taphrina aurea* also lacks mycelium, but the roots of the asci are between the epidermal cells. Another Taphrina is mentioned as occurring on fruits of *Populus tremula* L. and *P. alba* L. In this fungus the bases of the asci are inserted even farther between the epidermal cells.

The form on fruits of Populus is perhaps the species later described (56) as *T. rhizophora* Johans. The genus Taphrina is thus distinguished from the other two genera by the origin of the asci and by the fact that in Taphrina the asci are many-spored.

22. MAGNUS, P. Eine bemerkung zu Exoascus populi Thm. Hedwigia *14:* 1-3. 1875.

Having seen a specimen of von Thümen's *Exoascus populi* decides that it is *Taphrina aurea* Fr. States that it is uncertain whether the genus Ascomyces (as erected by Desmazières and Montagne) will eventually prove to be distinct from Taphrina. If it does not, the alder fungus, *A. tosquinetii*, represents a true genus type, and in that event Magnus proposes the genus name Endoascus.

23. MAGNUS, P. Zur Naturgeschichte der Taphrina aurea Pers. Hedwigia *14:* 97-98. 1875.

States that asci of *T. aurea* arise from a richly branched mycelium which grows between epidermal cells. Nearly every cell of this mycelium bears an ascus, leaving only rarely sterile cells between asci.

24. SOROKINE, N. Quelques mots sur l'Ascomyces polysporus. Ann. d. Sci. Nat. 6e ser. Botanique. *4:* 72. 1876.

Distinguishes three genera, Exoascus with intercellular mycelium, Taphrina with subcuticular mycelium, Ascomyces with no mycelium.

Describes a new species, *Ascomyces polysporus* Sorok. on leaves of *Acer tataricum* L.

25. BERKELEY, M. J., and C. E. BROOME. Notices of British Fungi. Ann. and Mag. Nat. Hist. *17:* 129-145. 1876.

Mentions (p. 144), with meager description, a new species, *Ascomyces alni* Berk. and Br., deforming the female catkins of alder.

Nothing is given which would distinguish this fungus from the fungus previously collected by Kühn (16) and ascribed to "Exoascus alnitorqua Tul." As Tulasne's *Taphrina alnitorqua* is a renaming of *Ascomyces tosquinetii* Westend., both Kühn's and Berkeley's fungi belong to *T. tosquineti* (Westend.) Tul. The first real separation of the form on catkins from that on leaves was made by Sadebeck (61). It was renamed by Magnus (70) *Taphrina alni-incanae* (Kühn) Magn.

Berkeley also mentions the occurrence on sloe of *"A. pruni* (Fkl.) Berk. and Br."

26. COOKE, M. C. Ravenel's American Fungi. Grevillea *6:* 129-146. 1878.

Describes as new *Ascomyces quercus* Cke. on leaves of *Quercus cinerea* Michx., from South Carolina.

There is nothing to distinguish this fungus from *T. caerulescens* and it was later so called by Robinson (55) and by Farlow (59).

27. FARLOW, W. G. List of fungi found in the vicinity of Boston. Bussey Institute Bull. *2:* 224-252. 1878.

Mentions the occurrence near Boston of *Taphrina aurea* Fr. on catkins of *Populus grandidentata* Michx., and *T. alnitorqua* Tul. on catkins of Alnus.

28. RÁTHAY, E. Ueber die von Exoascusarten hervorgerufenen degenerationen der laubtriebe einiger Amygdaleen. Sitzungsber. d. Math. Naturw. Cl. d. K. Acad. d. Wiss. *77:* 67-82. 1878.

Gives an account of careful studies which show that the mycelium of *Taphrina pruni* is not perennial.

Describes a new form on almond very similar to *T. deformans*. Does not distinguish it from the latter.

29. COOKE, M. C., and H. W. HARKNESS. Californian fungi. Grevillea *9:* 6-9. 1880.

Gives a meager description of a new fungus, *Ascomyces fulgens* Cke. and Hark. on leaves of *Arctostaphylos pungens* HBK.

The asci are reported to be dissolved and there is nothing to indicate that the fungus belongs to the Taphrinales. It was later pronounced by Harkness (California Acad. Sci. Bull. *1*: 256-268, 1886) to be an "aphidian gall," and was excluded from the genus by Giesenhagen (94).

30. FRANK, A. Die krankheiten der pflanzen. Breslau. 1880. pp. 521-524.

Gives descriptions of the following: *Ascomyces tosquinetii* Westend. (*Taphrina alnitorqua* Tul., *Exaoscus alni* de By.), on *Alnus glutinosa* Medic., *A. bullatus* on *Crataegus oxyacantha* L., *Taphrina aurea* Fr. on *Populus nigra* L., *Exoascus pruni* Fkl. on *Prunus domestica* L., *P. spinosa* L., and *P. padus* L., *E. deformans* Fkl. on peach. *T. aurea* is described as having asci with stalk cells.

Characterizes three genera as follows:

1. Ascomyces. No mycelium, each plant consisting of an ascus in the host epidermal cell, eight spores in an ascus, increasing by budding.
2. Taphrina. Again each plant is an ascus, but possesses a simple mycelium, developing between the epidermal cells of the host. Each ascus has numerous spores.
3. Exoascus. Mycelium well developed, intercellular. Each ascus has 6 to 8 spores.

31. RÁTHAY, E. Vorläufige mittheilung über die hexenbesen der kirschbäume und über Exoascus Wiesneri Ráthay. Oesterreich Bot. Zeitschr. *30:* 225. 1880.

The fungus causing witches' broom of cherry previously known as *Exoascus deformans* var. *cerasi* Fkl. is specifically distinct and is therefore renamed *Exoascus wiesneri* Ráthay. Occurs on *Prunus avium* L., *P. cerasus* L., and *P. chamaecrasus* Jacq. (*P. fruticosa* Pall.) Its mycelium is perennial in the diseased branches.

32. THÜMEN, F. VON. Diagnosen zu Thümens Mycotheca Universalis Centur. XIII bis XV. Flora *63:* 312-322, 323-332. 1880.

No. 1366 (issued 1879) is *Exoascus alni* de By. var. *strobilinus* Thm. on catkins of Alnus.

33. THÜMEN, F. VON. Zwei neue blattbewohnende Ascomyceten der flora von Wien. Verhandl. d. k. k. Zool.-Bot. Ges. in Wien. *29:* 523-524. 1880.

Describes as new *Ascomyces alutaceus* Thm. on leaves of *Quercus pubescens* Willd. This fungus is apparently identical with *T. caerulescens* and was reduced to synonymy by Giesenhagen (94).

34. SACCARDO, P. A. Fungi novi ex herbario professoris doct. P. Magnus Berolinensis. Michelia *1:* 117-132. 1880.

Describes as a doubtful species *Taphrina candicans* Sacc. on *Teucrium chamaedrys* L. This fungus was apparently never recognized as a Taphrina by later authors and it was excluded from the genus by Giesenhagen (94).

35. ROSTRUP, E. Mykologische Notizen. Bot. Centralbl. *5:* 153-154. 1881.

Names a new species, *Exoascus carpini* Rostr., causing witches' brooms of *Carpinus betulus* L., but gives no description beyond that of the effect on the host.

36. SADEBECK, R. Beobachtungen und untersuchungen über die pilzvegetation in der umgegend von Hamburg. Festschrift, seitens der botanischen gesellschaft zu Hamburg Sr. Magnificenz Herrn Burgermeister Dr. Kirchenpauer zur feier seines funfzig-jährigen Doctor-Jubilaums gewidmet. Hamburg 1881.

Notes on *Ascomyces tosquinetii* Westend., on a summer form of this causing white spots on leaves of *Alnus glutinosa* Medic., on a form attacking the female catkins of the same, on a similar form on *Betula alba* L., and on *Ascomyces bullatus* Berk. on *Crataegus* sp. Describes budding of spores of *A. tosquinetii* in water and sugar solutions and production of minute amounts of alcohol by budding spores.

37. RÁTHAY, E. Uber die hexenbesen der kirschbäume and über Exoascus wiesneri n. sp. Sitzungsber. d. k. Acad. d. Wiss. Math-naturw. Classe. *83:* 267-288. 1881.

Reports perennial mycelium for *E. wiesneri* Ráthay, causing witches' brooms of *Prunus avium* L., *P. chamaecerasus* Jacq., *P. cerasus* L., but maintains that *E. deformans* and *E. pruni* do not possess perennial mycelium. This is one of his reasons for considering the form on cherry a distinct species.

38. ROSTRUP, E. Sygdomme hos skovtraerne, foraarsagede af ikke-rustagtige snyltesvampe. II. Lövtraeer. Tidsskr. for Skovbrug. *4:* 113-206. 1881.

Characterizes Ascomyces as lacking mycelium, and having eight-spored asci, Taphrina as also without mycelium, but having many-spored asci, Exoascus as having intercellular mycelium with eight-spored asci. Mentions *Ascomyces tosquinetii* Westend. as attacking the fruits as well as the leaves of *Alnus glutinosa* Medic. States that the form has been previously named *A. tosquineti* var. *strobilina* Thm. by von Thümen in *Mycotheca universalis.*

The date (1879) of von Thümen's name for the fungus on alder fruits is later than that of Kühn's (16) var. *alni-incanae.*

39. KUTSOMITOPULOS, D. Beitrag zur kenntniss der Exoascus der kirschbäume. Sitzungsber. d. Phys-Med. Soc. zu Erlangen. *15:* 1-11. 1882.

Reports perennial mycelium for the fungus causing witches' broom of cherry. States that this fungus should not be called *E. wiesneri* since it had already been recognized as distinct by Fuckel (15) under the name *E. cerasi.*

Fuckel made this fungus a variety: *E. deformans cerasi.*

40. SADEBECK, R. Ueber die entwickelungsgeschichte der pilzgattung Exoascus und die durch einige arten der letzteren verursachten baumkrankheiten. Bot. Centralbl. *12:* 179-181. 1882.

Distinguishes two species on leaves of alder (*Alnus glutinosa* Medic and *A. incana* Willd.): one, which he calls *Exoascus alni,* affecting whole shoot-systems in the spring but later on causing separate spots on the leaves, and another, which he leaves unnamed, causing yellow spots on the under sides of leaves, and having asci filled with yellow protoplasm like those of *E. populi* (*Taphrina aurea*).

Describes the formation of ascogenous cells and elongation of asci by *E. alni* and other species, also the presence of sterile cells (which later die) among the ascogenous cells of the former. Reports perennial mycelium as occurring in the one-year twigs in the case of *E. bullatus* and in older parts in the case of forms causing witches' brooms, such as *E. carpini*. Reports successful inoculation of pear leaves with spores of *E. bullatus* and of alder leaves with *E. alni*. In the latter case observed penetration. Objects to Magnus' use of the name Ascomyces for the alder parasite.

41. Saccardo, P. A. Fungi gallici, Series II. Michelia *2:* 39-135. 1882. Describes (p. 86, No. 727) a new species, *Exoascus campestris* Sacc. on leaves of *Ulmus campestris* L.

This fungus is synonymous with *Taphrina ulmi* (Fkl.) Sadeb. according to Sadebeck (80) and Giesenhagen (94).

42. Saccardo, P. A. Fungi Dalmatici Pauci. Michelia *2:* 150-153. 1882.

Describes *Ascomyces alutaceus* Thm. in litt. on leaves of *Quercus robor* L. This fungus had previously been described by von Thümen (33).

43. Rostrup, E. Fortsatte undersøgelser over snyltesvampes angreb paa skovtraerne. Tidsskr. for Skovbrug. *6:* 199-300. 1883.

Describes a new species, *Taphrina betulina* Rostr. on *Betula alba* L., and *B. odorata* Bechst.

44. Farlow, W. G. Notes on some species in the third and eleventh centuries of Ellis' North American Fungi. Proc. Amer. Acad. Arts and Sci. *18:* 65-85. 1883.

Mentions *Ascomyces tosquinetii* and *Taphrina aurea*. Describes a new species, *Taphrina flava* Farlow on *Betula alba* L. Following Magnus distinguishes Taphrina as having subcuticular mycelium and polysporic asci with rootlike extremities between epidermal cells, and Exoascus with intercellular mycelium and 8-spored asci. *T. flava,* however, has some subepidermal mycelium.

Mentions, also, forms on *Prunus serotina* Ehrh. (which he thinks may be *E. pruni*) on *Potentilla canadensis* L., and on *Rhus copallina* L. (This, he believes, may be a variety of *E. deformans.*) The fungus here called by Farlow *Taphrina aurea* occurred on carpels and was later pronounced by Sadebeck (73) to be *T. johansonii.*

45. Peck, C. H. Report of the Botanist. New York State Mus. Nat. Hist. Ann. Rept. *33:* 17-72. 1883.

Reports occurrence of "*Exoascus pruni*" on fruits of *Prunus pumila* L. and *P. americana* Marsh. This is apparently the first report of the fungus later (80) described as *Exoascus communis* Sadeb.

46. Trelease, W. Preliminary list of the parasitic fungi of Wisconsin. Trans. Wisconsin Acad. Sci. *6:* 106-144. 1884.

Records the occurrence of *Exoascus pruni* Fkl. on fruits and of *Ascomyces caerulescens* Mont. and Desm. on *Quescus coccinea* Muensch. and *Q. rubra* L. These are new hosts for *T. caerulescens.*

47. Sadebeck, R. Untersuchungen über die pilzgattung Exoascus und die durch dieselbe um Hamburg hervorgerufenen baumkrankheiten. Jahrb. d. Hamburg. Wissensch. Anst. *1:* 93-124. 1884.

This paper contains a monographic account of the species known to date, including new species. Only the genus Exoascus is recognized, but in subdividing the genus certain characters are used which were later made the basis (80) of separating Exoascus and Taphrina.

The following is a condensed summary of Sadebeck's classification.

A. Mycelium perennial within shoots, fertile hyphae completely used up in the formation of asci, stalk cells present.
   1. *Exoascus pruni* Fkl.
   2. *E. bullatus* (Berk. & Br.) Fkl.
   3. *E. insititiae* Sadeb. (A new species.)
   4. *E. deformans* (Berk.) Fkl.

B. Mycelium perennial beneath cuticle and confined to that location.
   a. Fertile hyphae completely used up in formation of asci.
      a.a. Ascus with stalk cell.
   5. *E. alnitorquus* (Tul.) Sadeb.
   6. *E. turgidus* Sadeb. (A new species.)
   7. *E. flavus* Sadeb. (A new species.)
   8. *E. betulae* Fkl.
      b.b. Ascus lacking a stalk cell.
   9. *E. aureus* (Pers.) Sadeb.
   10. *E. coerulescens* (Desm. and Mont.) Sadeb.
   11. *E. carpini* Rostr.
      b. Not all of the fertile hyphae used in the formation of asci, the latter consequently more or less scattered.
   12. *E. epiphyllus* Sadeb. (A new species.)
   13. *E. ulmi* Fkl.

Of the new species described *E. alnitorquus*[1] on female catkins of *Alnus glutinosa* Medic. and *A. incana* Willd., and on twigs and leaves of *A. glutinosa* x *incana* Krause (*A hybrida* A. Br.), is split off from the species previously known as *Ascomyces tosquinetii* Westend. (*Exoascus alni* de By.); *E. flavus* (also considered to have been included in the foregoing) causes yellow spots on leaves of *Alnus glutinosa,* and its asci have yellow contents; *E. epiphyllus* swells and curls the leaves of *Alnus incana; E. insititiae,* causing witches' broom on *Prunus insititia* L., is perhaps a form previously considered to belong to *E. pruni;* and *E. turgidus* seems to be a renaming of *T. betulina* Rostrup.

In this paper Sadebeck also gives a circumstantial account of the occurrence and development of perennial mycelium in *E. alnitorquus* (*T. tosquinetii*), the cultivation of this form in artificial media, successful inoculations and observation of penetration (the germ tube entering the radial wall between two epidermal cells). He also figures nuclear division in a young ascus.

E. ulmi is also stated to have perennial mycelium, a statement which Sadebeck (80) later retracts.

48. FISCH, C. Ueber die pilzgattung Ascomyces. Bot. Zeit. *43:* 34-39, 49-59. 1885.

1. This is essentially a new species since *T. alnitorqua* Tul. and *E. alni* de By. had not been previously recognized as distinct from *T. tosquinetii.*

Using the genus name Ascomyces in the sense of Magnus (21), *i.e.:* for forms lacking mycelium, Fisch renames *Ascomyces tosquinetii* Westend. as *A. endogenus* Fisch. This is done because the name *A. tosquinctii* has been applied to several species, Sadebeck having described three species from alder. *A. endogenus* is stated to have no mycelium, the ascus being developed within an epidermal cell of the host.

Infection was obtained when spores were sown on leaves in plum decoction. Penetration is figured and shows what was long interpreted as production of a secondary spore or appressorium, but may possibly be a case of copulation of conidia such as was reported much later by Wieben (176) for *Taphrina epiphylla.* Fisch's fungus, however, must have been either *T. tosquinetii* or *T. sadebeckii* since the host was *Alnus glutinosa.* Copulation of conidia has not been reported for these species. Fisch also reports having produced infection with *Exoascus epiphyllus* (*T. epiphylla*) and having seen penetration.

A. endogenus and *E. epiphyllus* are said to occur on the same host, but never on the same shoot.

49. FISCH, E. Ueber Exoascus aceris Linh. Bot. Centralbl. *22:* 126-127. 1885.

Besides the fungus described by Sorokine (24) as *Ascomyces polysporus* on *Acer tataricum* L. there is another on the same host, distributed by Linhart in Fungi Hungarici. This is described as *Exoascus aceris* Linh. It belongs to those forms in which the subcuticular mycelium all divides up into ascus-producing cells, leaving no sterile members between.

These two fungi are considered to be the same species, *T. polyspora* (Sorok.) Johans. by Johanson (52), Sadebeck (73), and Giesenhagen (94).

50. ROSTRUP, E. Om nogle of Snyltesvampe foraarsagede hos blomster planter. Bot. Tidsskr. *14:* 230-243. 1885.

Names, without description, a new species, *Taphrina umbellifcrarum* Rostr. on *Heracleum sphondylium* L., and *Peucedanum palustre* Much. This fungus was subsequently removed from the Taphrinaceae by Juel (114), and placed in the genus Taphridium of the Protomycetaceae.

Also describes a new species, *Taphrina tormentillae* Rostr. on *Tormentilla erecta* (*Potentiila silvestris* Neck.). This fungus was mentioned, though not described, by Farlow (44). For this reason it was named by Johanson (52) *Taphrina potentillae* (Farl.) Johans.

51. PECK, C. H. Report of the Botanist. New York State Mus. Nat. Hist. Ann. Rept. *39:* 30-73. 1886.

Describes a new species, *Ascomyces extensus* Pk., on leaves of *Quercus macrocarpa* Michx. This fungus was later referred by Farlow (59) to *Taphrina caerulescens* (Mont. and Dsm.) Tul.

52. JOHANSON, C. J. Om svampslägtet Taphrina och dithörande svenska arter. Ofvers of Kongl. Svensk. Vetensk. Akad. Forhandl. *1885:* 29-47. 1886.

On the basis of priority unites all species of Taphrina, Exoascus, and Ascomyces into one genus, Taphrina. Describes as new *Taphrina nana* Johans. on *Betula nana* L., *T. sadebeckii* Johans. on *Alnus glutinosa* Medic., *T. sadebeckii* var. *borealis* Johans. on *Alnus incana* Willd. in lower alpine regions, *T.*

carnea Johans. on *Betula odorata* Bechst., *B. nana* L., and *B. intermedia* Thomas. Notes occurrence in Sweden and Denmark of *T. potentillae* (Farlow) Johans. on *Potentilla tormentilla* L., and *P. geoides L.* Gives a description of *Taphrina polyspora* Sorok. as it occurs on *Acer tataricum* L. in Sweden, and states that its asci agree in form and size with those of *Exoascus aceris* Linh.

T. sadebeckii Johans. is a renaming of *Exoascus flavus* Sadeb., the latter species name having been preëmpted by Farlow (44).

53. SADEBECK, R. Ueber die im ascus der Exoasceen stattfindende entwickelung der inhaltsmassen. Sitzungsber. d. Ges. f. Bot. in Hamburg. Bot. Centralbl. *25:* 123-125. 1886.

Describes ascus formation in *Exoascus flavus* Sadeb. (*Taphrina sadebeckii* Johans.) and *E. alnitorquus* (Tul.) Sadeb. A globose uninucleate ascogenous cell elongates to a cylinder, its nucleus divides by mitosis, a septum between these two nuclei cuts off the stalk cell, the ascus-nucleus then divides rapidly to form 2, 4, and 8 nuclei, around these the spores form.

54. MEEHAN, T. Formation of crow's nest branches in the cherry tree. Acad. Nat. Sci. Philadelphia Proc. *1886:* 273-274. 1887.

Reports witches' brooms on "wild cherry" (species not named) due to a fungus identified by Farlow as *Exoascus Wilsneri* (sic).

55. ROBINSON, B. L. Notes on the genus Taphrina. Ann. Bot. *1:* 163-176. 1887.

Agrees with Sadebeck (47) that a single genus should be recognized, but with Johanson (52) that it should be called Taphrina. Gives the following list of species known to occur in America: *Taphrina pruni* (Fkl.) Tul., *T. deformans* (Berk.) Tul., *T. purpurascens* Robinson, *T. potentillae* (Farl.) Johans., *T. flava* Farl., *T. alnitorqua* Tul., *T. caerulescens* (Mont. and Desm.) Tul.

T. pruni is known to occur commonly on *Prunus domestica* L. A closely similar and probably identical form occurs on fruits of *P. maritima* Wang., *P. virginiana* L., and *P. serotina* Ehrh. A form resembling *T. deformans* has been observed on leaves of cherry (see 54) and on leaves and twigs of *P. serotina.* The new species, *T. purpurascens,* occurs on leaves of *Rhus copallina* L. *T. flava* occurs on *Betula alba* L. var. *populifolia* Spach., and *B. papyracea* Ait. *T. alnitorqua* occurs on alder catkins, but has not been found on leaves. *T. aurea* affects catkins of *Populus grandidentata* Michx. *Ascomyces quercus* Cke. (26) is synonymous with *T. caerulescens.*

56. JOHANSEN, C. L. Studier öfver svampslagtet Taphrina. Bihang till Kongl. Svensk. Vetensk. Akad. Handlingar *13:* 3-28. 1887.

This paper reports careful investigations which show that *T. carnea* Johans. and *T. sadebeckii* Johans. do not possess perennial mycelium. *T. betulae* Fkl., though not investigated, is probably similar in this respect. These forms are in contrast to *T. betulina* Rostr., *T. alnitorqua* Tul., and *T. borealis* Johans., whose mycelium is perennial in the buds of the host. It is suggested that in both perennating and non-perennating forms new infections arise from over-wintering bud conidia. New species described are: *Taphrina alpina* Johans. on *Betula nana* L., *T. bacteriosperma* Johans. on the same host, and *T. rhizophora*

Johans. on *Populus alba* L., and *P. tremula* L. Descriptions are also given of *T. filicina* Rostr. on *Polystichum spinulosum* (*Aspidium spinulosum*) (O. F. Müll) Sw., of *T. aurea* Fries, and *T. rhizophora* Johans. This is the first careful description of *T. aurea*. (Sadebeck's [47] description was based on the form occurring on the fruits and this, as will be seen, is *T. rhizophora*.) It is pointed out that the ascus of this fungus is provided with a stalk cell, a fact not previously recognized except by Frank (30). The new species, *T. rhizophora*, is distinguished from the preceding by lack of a stalk cell and by a narrowed basal portion of the ascus extending inward between epidermal cells of the host. *T. aurea* occurs on leaves of *Populus nigra* L. and *P. pyramidalis* (*P. alba* L. var. *pyramidalis* Bunge.), while *T. rhizophora* deforms fruits of *P. alba* L. and *P. tremula* L. The latter species occurs in North America on fruits of *P. tremuloides* Michx. (Ellis and Everhart, North America Fungi, No. 1885). *T. sadebeckii* Johans. var. *borealis* Johans. is raised to specific rank, becoming *T. borealis* Johans. A table is presented showing the world distribution of the 21 Swedish species, together with a discussion of this distribution and of the antiquity of certain species. *T. bacteriosperma* is thought to be very old.

The species on *P. tremuloides* was later referred by Patterson (92) and Sadebeck (93) to *Taphrina johansonii* Sadeb.

57. KNOWLES, E. L. The "curl" of peach leaves: a study of the abnormal structure induced by Exoascus deformans. Bot. Gaz. *12:* 261-218. 1887.

A description of the histological changes induced in the peach leaf by *Taphrina deformans*.

58. PECK, C. H. Report of the Botanist. New York State Mus. Nat. Hist. Ann. Rept. *40:* 39-77. 1887.

Describes two new species, *Ascomyces letifer* Pk. on leaves of *Acer spicatum* Lam., and *A. rubrobrunneus* Pk. on leaves of *Quercus rubra* L.

59. FARLOW, W. G. A provisional host-index of the fungi of the United States. Cambridge, 1888.

Gives a list with synonyms of all American species of Taphrina (Ascomyces, Exoascus) so far known. *Taphrina alnitorqua* auct. Amer. on catkins of *Alnus incana* Willd. and *A. rubra* Bong. is referred to *T. alni-incanae* (Kühn) Magnus, and *T. aurea* auct. Amer. on fruits of *Populus fremontii* Watson, *P. grandidentata* Michx., *P. pyramidalis* Roz., and *P. tremuloides* Michx. to *T. rhizophora* Johans. *Ascomyces quercus* Cke. on *Quercus alba* L., *Q. cinerea* Michx., *Q. coccinea* Wang., *Q. douglasii* Hook and Arn., *Q. laurifolia* Michx., and *Ascomyces extensus* Pk., on *Q. macrocarpa* Michx. are referred to *Taphrina caerulescens* (Mont. and Desm.) Tul. *Ascomyces rubrobrunneus* Pk. on *Quercus rubra* L. is recognized as a distinct species.

60. MASSALONGO, C. Uber eine neue species von Taphrina. Bot. Centralbl. *34:* 389-390. 1888.

Describes a new species, *Taphrina ostryae* Massal., on leaves of *Ostrya carpinifolia* Scop.

61. SADEBECK, R. Neue untersuchungen über einige krankheitsformen von Alnus incana und glutinosa. Sitzungsber. d. Ges. f. Bot. zu Hamburg. *4:* 90. 1888.

States that infection experiments have shown that *E. epiphyllus* Sadeb. (*T. epiphylla* [Sadeb.] Johans.) causes witches' brooms on twigs of *Alnus incana*. Claims that *T. borealis* Johans. is not distinct from *E. epiphyllus* (*T. epiphylla*). The latter species and *E. alnitorquus* (*T. alnitorqua* Tul.) may infect the same leaf of *Alnus glutinosa* Medic. and their asci may be intermingled. Yellow spots on leaves of Alnus are caused by *E. sadebeckii* (*T. sadebeckii* Johans.). Another fungus deforms the pistillate aments of *A. glutinosa* and *A. incana*. This is named (without adequate description) a new species, *Exoascus amentorum* Sadeb. Its asci in form and size and in lack of stalk cell resemble those of *Ascomyces endogenus* Fisch.

62. TUBEUF, C. von. Neue parasitäre pilze aus dem Bayerischen walde. 3. Hexenbesen auf Alnus incana. Beiträge zur kenntniss der baumkrankeiten. Berlin. 1888. pp. 37-40.

Describes and figures a witches' broom on *Alnus incana* Willd. as caused by *Taphrina borealis* Johanson.

63. BRIOSI, G. Elenco delle ricerche fatte al laboratorio di botanica crittogamica di Pavia nei mesi settembre e ottobre 1889. Ministerio di Agricolt. Industre, Commercio. Bull. di Notize agrarie. *11:* 2228-2231. 1889.

Reports a new host, *Quescus cerris* L., for *Taphrina caerulescens*.

64. BRITTON, N. L. Catalogue of plants found in New Jersey. Final Report State Geologist. *2:* 28-642. 1889.

Mentions (p. 507) several species of Taphrina occurring in New Jersey. Of these *T. aurea* Fr. on leaves of *Populus tremuloides* Michx. is a new record for eastern North America. The same fungus had been previously reported from California by Harkness (California Acad. Sci. Bull. 1. 1896) as occurring on *P. dilatata* Ait., and *P. fremontii* Watson.

65. MASSALONGO, C. Nova species e genere Taphrina. Nuov. Giorn. Bot. Ital. *21:* 422-423. 1889.

Describes a new species, *Taphrina oreoselini* Massal. on *Peucedanum oreoselinum* Moench. This species is quite similar to *T. umbelliferarum* Rostr. found by Rostrup (50) on *Heracleum sphondylium* L., and *Peucedanum palustre* Moench.

Both these species were later placed by Juel (114) in the genus Taphridium of the Protomycetaceae.

66. MAYR, H. Die waldungen von Nordamerika, ihre holzarten, deren anbaufähigkeit und forstliche werth fur Europa im allgemeinen und Deutschland inbesondere. München (Rieger). 1889.

Mentions the occurrence of a witches' broom on *Quercus lobata* Nee. Suggests the possibility of this being caused by *"Exoascus Quercus lobatae* n. sp. (?)." No fungus was seen.

67. PASSERINI, G. Diagnosi di funghi nuovi, Nota IV. Atti d. R. Accad. d. Lincei. Ser. 4. *6:* 457-470. 1889.

Describes a new species, *Exoascus aemiliae* Passer. on *Celtis australis* L. Although the date on the title page is 1889, this volume of the proceedings must have actually been published later, since the session of the Academy at which this report was made was that of March, 1890. Giesenhagen (94) reduces this fungus to synonymy as *Taphrina celtis* Sadeb.

68. HARKNESS, H. W. Curled leaf. Zoe *1:* 87-88. 1890.

Describes a witches' broom on *Aesculus californica* caused by an Ascomyces which may be identical with *Ascomyces deformans* (sic). This fungus was later named by Patterson (92) *Exoascus aesculi* (Ell. and Ev.) Patterson.

69. KRUCH, O. Sopra un caso di deformazione (Scopazzo) dei rami dell 'Elce. Malpighia *4:* 424-430. 1890.

Describes the effect on the host of a newly found species of Taphrina causing witches' brooms on *Quercus ilex* L.

70. MAGNUS, P. Bemerkung über die benennung zweier auf Alnus lebender Taphrina-arten. Hedwigia *29:* 23. 1890.

In view of the work of Johanson (52) and Sadebeck (47) believes that all species should be placed in one genus, Taphrina. Has examined original material of *Ascomyces tosquinctii* Westend. and says it is identical with *Taphrina alnitorqua* Tul. and should be called *T. tosquinctii* (Westend.) P. Magnus.

Calls attention to the fact that *Exoascus amentorum* Sadeb. was first described as *E. alnitorqua* (Tul.) J. Kühn, forma *alni-incanae* J. Kühn in litt. (16), and later as *E. alni* de By. var. *strobilinus* Thm. (von Thümen, Mycotheca Universalis, No. 1366. 1879). It should be called *T. alni-incanae* (J. Kühn) P. Magnus.

71. ROSTRUP, E. Taphrinaceae Daniae. Vidensk. Meddel. fra den Naturh. Forening. i Kijbenhavn. *1890:* 246-264. 1890.

This paper gives descriptions, with a key for identification and a host index, of twenty species of Taphrina found in Denmark.

New hosts are given as follows: for *Taphrina pruni* (Fkl.) Tul.—*Prunus insititia* L., for *T. crataegi* Sadeb.—*Crataegus monogyna* Jacq., for *T. insititiae* Sadeb.—*Prunus spinosa* L., for *T. aurea* Fr.—*Populus monilifera* Ait. (*P. deltoides* Marsh.), for *T. bullata* (Berk.) Tul.—*Cydonia japonica* Hort. (*Chacnomeles lagenaria* Koidz.).

The following species are listed as having mycelium perennial in the twigs: *T. pruni, T. cerasi, T. crataegi, T. deformans, T. insititiae;* the following have mycelium perennial in the buds: *T. epiphylla, T. ulmi, T. bullata, T. tosquineti, T. betulina.*

Two new species are described, *T. githaginis* Rostr. on *Agrostemma githago* L., and *T. lutescens* Rostr. on *Lastraea thelypteris* (*Aspidium thelypteris* (L.) Sw.).

72. TUBEUF, C. VON. Botanische excursionen mit den Studirenden der Forstwissenschaft an der Universität München. Allgem. Forst-und Jagdzeit. *66:* 25-33. 1890.

The witches' brooms on white alder were first described and figured by Tubeuf in 1888 (62). The fungus was named *T. sadebeckii* var. *borealis* by Johanson. Sadebeck has since claimed that this fungus is identical with *E. epiphyllus* (*T. epiphylla*). No doubt the fungi are identical, but this will necessitate a revision of the description of *E. epiphyllus,* since Sadebeck has not mentioned its causing witches' brooms nor its possession of perennial mycelium. (See 61.)

73. SADEBECK, R. Kritische untersuchungen über die durch Taphrina-arten hervorgebrachten baumkrankheiten. Jahrb. d. Hamburg. Wissensch. Anst. *8:* 61-95. 1890.

In this paper Sadebeck disagrees with Johanson (56) and claims that *Taphrina carnea, T. betulae,* and *T. sadebeckii* possess perennial mycelium. Pointing out that strict adherence to priority would call for the use of the name Taphria, (since Fries in 1815 described the poplar fungus as *Taphria populina, aurea,* changing the genus name to Taphrina in 1825), he accepts the name Taphrina for the united genus containing all forms described as Taphrina, Exoascus, and Ascomyces.

Agrees with Johanson that the species *Taphrina aurea* Fr. should be restricted to the form on leaves of *Populus nigra,* but does not agree that this fungus has a well-defined stalk cell. The form on carpels of *Populus alba* is *T. rhizophora* Johans., that on fruits of *P. tremula* is named as *T. johansonii* Sadeb. with the description given earlier (47) for *Exoascus aureus* (*T. aurea* Fr.). Does not know where the American form on *P. tremuloides* Michx. belongs.

Describes successful inoculation experiments on *Alnus incana* with ascospores (unsuccessful with conidia) of *T. epiphylla* and *T. borealis,* concluding that the two species are the same. Gives a revised description of *T. epiphylla* and describes a new variety of the species, *T. epiphylla* var. *maculans* Sadeb. causing spots on leaves of *Alnus glutinosa.* Infection experiments with this fungus did not succeed.

The fungus which deforms fruits of *Alnus incana* and *A. glutinosa* has been variously known as *Exoascus alnitorquus* Tul. forma *alni-incanae* Kühn. (16), *Ascomyces alni* Berk. & Br. (25), *E. alni* de By. (15), and *E. alni* de By. var. *strobilinus* Thm. (70). It was earlier (61) raised to specific rank as *E. amentorum* Sadeb. Magnus (70) changed the name on basis of priority to *T. alni-incanae* (J. Kühn) Magnus. It is now accepted as *T. alni-incanae* (J. Kühn) Sadeb., since Magnus and other early authors made no study of the characters of the fungus. An amended description of *T. tosquinetii* (Westend.) Magnus is given to exclude the preceding fungus (on fruits). *T. tosquineti* affects leaves and twigs of *Alnus glutinosa.* The name *T. Sadebeckii* Johans. for the fungus previously described (47) as *E. flavus* Sadeb. is accepted. This fungus causes yellow spots on leaves of *Alnus glutinosa.* Description is given of a new species, *Taphrina celtis* Sadeb. on leaves of *Celtis australis* L. The fungus on *Crataegus oxyacantha L.,* formerly (47) included in *Taphrina bullata* (Berk.) Tul., is separated as a new species, *T. crataegi* Sadeb. Spores of this form caused no infection on pear leaves, while previously (40) spores from pear to pear had caused infection. The diagnosis here given for *T. crataegi* is that formerly (47) used for *T. bullata. Taphrina bullata* as it occurs on pear is now redescribed. Dimensions of asci are different from those given by Tulasne (14), since he employed only dried material. Due to the shrinkage of asci in this species fresh material or material preserved in alcohol is necessary.

A new species, *T. minor* Sadeb. occurring on *Prunus chamaecrasus* Jacq., is described.

Taphrina deformans (Berk.) Fkl. is restricted to the form on peach and perhaps the form on *Prunus armeniaca* L. A description is given.

The fungus causing witches' brooms on *Prunus avium* L. and *P. cerasus* L., formerly known (15) as a variety of *T. deformans,* is raised to specific rank, becoming *T. cerasi* (Fkl.) Sadeb.

Taphrina insititiae Sadeb., heretofore known as causing twig and leaf deformations on *Prunus insititia* L., is now recognized as affecting in the same manner *P. domestica* L.

Taphrina pruni (Fkl.) Tul. is described and stated to occur on fruits of the following: *Prunus domestica* L., *P. padus* L., and *P. virginiana* L.

A new species, *T. farlowi* Sadeb. is described as occurring on fruits of *Prunus serotina* Ehrh. in North America.

Two lists are given of the 32 known species of Taphrina, one on the basis of hosts affected, the other on the basis of possible relationships in the genus. In this second list the species are arranged in the following groups:

I. Ascogenous layer subcuticular.
   A. Possessing perennial mycelium.
   B. Lacking perennial mycelium.
II. Ascogenous cells intercellular, between epidermal cells or deeper in host.

74. BREFELD, O. Untersuchungen aus dem gesamtgebiete der Mycologie. IX. Die Hemiasci und die Ascomyceten. Münster. 1891.

Reports culturing in nutrient solutions the budconidia of *Taphrina rhizophora* Johans. (obtained from fruits of *Populus tremula*). States that the dried conidia retained their ability to germinate for many months. Similar results were obtained with *Exoascus deformans* Berk. Suggests that the genus be divided into Taphrina, with 4 spores in the ascus, and Exoascus with 8.

This is a curious suggestion, since all previous work had shown that species of Taphrina (or Exoascus) bore normally 8 spores in an ascus, unless by budding of ascospores the ascus became filled with conidia and hence were many-spored.

75. VUILLEMIN, P. L'Exoascus kruchii sp. nov. Rev. Mycol. *13:* 141-142. 1892.

Describes a new species, *Exoascus kruchii* Vuill. on *Quercus ilex* L.

The occurrence of this fungus was previously reported by Kruch (69).

76. MASSALONGO, C. Intorno alla Taphrina polyspora (Sor.) Johans., var. pseudoplatani. Bull. d. Soc. Bot. Ital. 1892:197-199. 1892.

Describes a new variety, *Taphrina polyspora* (Sor.) Johans., var. *pseudoplatani* Massal. on *Acer pseudoplatanus* L.

77. GIESENHAGEN, K. Ueber hexenbesen an tropischen farnen. Flora *76*:130-156. 1892.

From herbarium material collected in Ceylon describes two new species, *Taphrina cornu-cervi* Giesenhag. on *Aspidium aristatum* Sw. (*Polystichum aristatum* Presl.) and *T. laurencia* Giesenhag. on *Pteris quadriaurita* Retz. No spores were present in the asci of either of these fungi. Divides Taphrina into two subgenera; Eutaphrina, with mycelium intercellular or subcuticular, and Taphrinopsis, with mycelium and asci formed within the epidermal cell of the host. In Eutaphrina are placed *T. cornu-cervi* and all previously described species, in Taphrinopsis *T. laurencia*.

78. WAKKER, J. H. Untersuchungen über den einfluss parasitischer pilze auf ihre nährpflanzen. Versuch einer pathologischen anatomie der pflanzen. Jahrb. f. Wissensch. Botanik *24*:529-548. 1892.

Contains a brief account of the morphological and histological changes induced in *Prunus padus* by *Taphrina pruni* and in *Alnus glutinosa* by *T. alni-incanae* (*Exoascus alnitorquus*).

79. PAMMEL, L. H. Notes on some fungi common during the season 1892 at Ames, Iowa. Agric. Sci. *7*:20-27. 1893.

Mentions the occurrence of *Taphrina deformans* on peach, "*T. pruni*" on *Prunus chicasa* (*P. angustifolia* Marsh.), and *P. americana* Marsh., and *T. aurea* on leaves of *Populus certinensis* Dieck. (*P. berolinensis* Dipp. [?]. According to L. H. Bailey in Cyclopedia of Horticulture, the "*Populus certinensis*" grown in America may not be correctly named), and *P. monilifera* Ait. (*P. virginiana* Fourg.).

80. SADEBECK, R. Die parasitischen Exoasceen, eine monographie. Jahrb. d. Hamburg. Wissensch, Anst. *10*:5-110. 1893.

Objects to Brefeld's division of the genus into Exoascus with 8 spores, and Taphrina with 4. From a study of *Taphrina ulmi*, Sadebeck finds that many asci are 8-spored while others are only 4-spored. A similar variation in spore number was observed in *T. bullata*, *E. epiphyllus* and *E. farlowi*. Spore number cannot be made the basis of generic distinction.

Sadebeck, however, would now divide the genus into three: Exoascus, Taphrina, and Magnusiella. Exoascus has perennial mycelium, deforms shoots as well as leaves, and all of its subcuticular mycelium separates without previous differentiation into ascogenous cells. Taphrina lacks perennial mycelium, causes spots on leaves only, and its subcuticular mycelium differentiates into fertile and sterile cells, the former becoming mother cells of the ascogenous cells, the latter degenerating. Magnusiella forms no ascogenous layer, the asci arising on the ends of branches of the intercellular mycelium.

He excludes the genus Ascomyces, which has been characterized by lack of mycelium, believing that Westendorp in describing *A. tosquinetii*, and Fisch with *A. endogenus*, were mistaken as to lack of mycelium, and that both had *Taphrina sadebeckii* Johans.

The account of his previous (47) investigations showing that *E. tosquinetii* possesses perennial mycelium is repeated. It is also stated (without evidence) that mycelium of *E. epiphyllus*, *E. betulinus*, *E. turgidus*, and *E. carpini* is perennial in the buds. (Later in the paper the earlier [47] statement that *T. ulmi* has perennial mycelium is corrected.) In these forms the mycelium grows from the bud-anlage into the leaves, where it develops subcuticularly.

With *E. tosquinetii* (Westend.) Sadeb. observed germination of spores and formation of hyphae in artificial culture, but was unable to keep cultures going for very long. He succeeded in obtaining infection with this fungus by inoculating buds and young seedlings. He corrects his former statement (47) that in formation of ascogenous cells by *E. tosquinetii* there is a differentiation into sterile and fertile hyphae. This statement and the accompanying discussion should have referred to *T. sadebeckii* Johans.

By way of contrast three forms causing deformation of shoots of the host (*E. pruni*, *E. rostrupianus*, *E. tosquinetii*) have mycelium, which is perennial in the twigs, and grows intercellularly in the new leaves. The forms listed under Taphrina do not have perennial mycelium, and these fungi never form hyphae in nutrient solutions. A full description is given of the manner of

formation of ascogenous cells in Exoascus and Taphrina (see above). The subcuticular habit of mycelium of Taphrina, and the disappearance of the sterile mycelium after formation of ascogenous cells results in no mycelium being left in the host to become perennial.

New species described are: *Exoascus communis* Sadeb. on *Prunus americana* Marsh., *P. pumila* L., and *P. maritima* Wang., and *E. rostrupianus* Sadeb. on *Prunus spinosa* L.

A complete host index of known species, a taxonomic account of all known species, with full description of each one, and a table showing world distribution of these species are presented. Twenty-one species of Exoascus, fourteen of Taphrina, and five of Magnusiella are listed.

81. SCHROETER, J. Die Pilze. In Cohn, F. Kryptogamenflora von Schlesien. Vol. 3, pp. 8-15. 1893.

Makes two genera, Exoascus with 8-spored asci, and Taphria with asci becoming many-spored by budding of the ascospores. Gives descriptions of eleven species of Exoascus, and seven species of Taphria (all of which have been previously described) with notes of their occurrence in Silesia.

82. HENNINGS, P. Taphrina gilgii P. Hennings et Lindau n. sp., eine neurer parasitischer pilz der Mark. Hedwigia *32*:156-157. 1893.

Describes a new species, *Taphrina gilgii* P. Henn. and Lindau, on *Prunus cerasus* L. Distinguished from *T. cerasi* by its broader asci.

83. ROUMEGUÉRE, C. Fungi exsiccati praecipué gallici, LXIIIe Centurie, puqliée avec le concours de MM. Briard, F. Cavara, Eugène Niel, F. Fautrey, R. Ferry, L. Boudier, Lambotte, L. Quélet, C. Raoult, et L. Rolland, et les Reliquiae de Balansa. Revue Mycologique *16*:15-25. 1893.

In this list of exsiccati No. 6228 is described as a new species, *Exoascus marginatus* Lamb. and Fautr., occurring on *Crataegus oxyacantha* L.

This specimen was later determined to show only injury due to Erineum mites. See Jaczewski (170.)

84. MASSALONGO, C. Nuova contribuzione alla Micologia Veronese. Malpighia *8*:97-130. 1894.

Describes a new species, *Taphrina acericola* Massal. on *Acer campestris* L. Changes *T. polyspora* Sorok. var. *pseudoplatani* Massal. to *T. acericola* (Massal.) var. *pseudoplatani* Massal. Also reports as "new" hosts for *T. caerulescens* (Mont. and Desm.) Tul. *Quercus cerris* L., *Q. pedunculata* (*Q. robur* L.), *Q. pubescens* Willd.

85. PATTERSON, F. W. Species of Taphrina parasitic on Populus. Bot. Gaz. *19*:380. 1894.

The fungus occurring in America on fruits of *Populus tremuloides* Michx. and Populus spp. which has been called *Taphrina aurea* Fr. and subsequently (56) (59) *T. rhizophora* Johans. is really *T. johansonii* Sadeb. *T. aurea*, which occurs only on leaves, has not heretofore been observed in America. Recently a form differing but slightly from this last named species has been found in Iowa, on leaves of several species of Populus. (See 79.)

86. ATKINSON, G. F. Notes on some Exoascaceae of the United States. Bull. Torr. Bot. Club *21*:372-380. 1894.

Presents, with notes and discussion, a list of fifteen species occurring in the United States. New species are: *Exoascus confusus* Atk., deforming fruit and floral envelopes of *Phunus virginiana* L., *E. longipes* Atk. on leaves of *Prunus americana* Marsh., *E. decipiens* Atk. on leaves of *Prunus americana* Marsh., *E. decipiens* Atk. var. *superficialis* Atk. on half grown fruits of *P. americana*, *E. mirabilis* Atk. on shoots of *Prunus angustifolia* Marsh., buds of *P. hortulana* Bailey, and *P. americana* Marsh., *E. mirabilis* Atk. var. *tortilis* Atk. on fruits of *P. angustifolia* and *P. americana*, *E. rhizipes* Atk. on buds and fruit of *Prunus triflora* Roxb., *E. varius* Atk. on leaves of *Prunus serotina* L., *E. cecidomophilus* Atk. on galls formed by insect larvae on fruits of *Prunus virginiana* L., *E. australis* Atk. on leaves of *Carpinus americana* Michx. (*C. caroliniana* Walt.).

Exoascus insititiae Sadeb. is recorded as occurring on a new host: *Prunus pennsylvanica* L. *Taphrina aurea* Fr. is reported on leaves of *Populus monilifera* Ait. The species on aments of *Populus tremuloides* Michx. which has been called *T. aurea* has been referred by Farlow (59) to *T. rhizophora* Johans. Material from Ithaca, New York, examined by Atkinson is said to be *T. rhizophora* (see 92). Meechan's specimen (54) mentioned by Robinson (55) is reported as *Exoascus cerasi* (Fkl.) Sadeb. on *Prunus avium* L.

87. ATKINSON, G. F. Leaf curl and plum pockets. Cornell Univ. Agric. Exp. Sta. Bull. 73. 1894.

This is an account of the prunicolous species discussed in the preceding paper.

88. COCCONI, G. Ricerche sullo svillupo evolutivo di duo specie nuove di funghi, Lagenidium papillosum ed Exoascus flavo-aureus e sul parasittismo della Phoma uncinulae sull Uncinula adunca Lev. Mem. d. R. Accad. d. Sci. d. Inst. d. Bologna. Ser. 5. *4*:187-198. 1894.

Describes as a new species, *Exoascus flavo-aureus* Cocc. on *Populus pyramidalis* Roz. (*P. alba* L., var. *pyramidalis* Bunge). This fungus is distinguished from *T. aurea* Fr. by the variability of the basal portion of the ascus. This may be prolonged to a tapering rhizoid between the host epidermal cells.

89. SMITH, W. G. Untersuchungen der Morphologie und Anatomie der durch Exoasceen verursachten Spross-und blattdeformationen. Forstlich. Naturwiss. Zeitschr. *3*:420-427, 433-465, 473-482. 1894.

A study of the morphological and anatomical changes induced in their various hosts by *Taphrina aurea*, *T. betulae*, *T. carnea*, *T. caerulescens*, *T. cerasi*, *T. deformans*, *T. epiphylla*, *T. insititiae*, *T. minor*, *T. polyspora*, *T. pruni*, *T. tosquinetii*, *T. turgida* (or other species on *Betula verrucosa*), and *Taphrina* sp. on *Prunus padus*.

90. DANGEARD, P. A. La reproduction sexuelle des Ascomycetes. Le Botaniste 4e ser. *4*:21-61. 1895.

An account of the cytology of *Taphrina deformans*. Cells of the intercellular mycelium and young ascogenous cells are binucleate. Nuclear fusion occurs in the ascogenous cell. This cell then puts forth a papilla which elongates to become the ascus, the fusion nucleus migrates to the center of the ascus and divided by three successive divisions to form the nuclei for the spores. A septum forms across the base of the ascus, cutting off a basal cell. The septum is considered of no importance.

91. ELIASSON, A. G. Taphrina acerina n. sp. Bihang t. Kongl. Svenska Vetenskaps-Akad. Handl. *20*:3: 4: 3-6. 1895.

Describes a new species, *Taphrina acerina Eliass.* on *Acer platanoides* L.

92. PATTERSON, F. W. A study of North American Parasitic Exoasceae. Bull. Lab. Nat. Hist. Univ. Iowa *3:* 89-135. 1895.

This is a detailed account of the sixteen American species known to date. Sadebeck's classification is followed and nine species are listed under Exoascus, five under Taphrina and two under Magnusiella.

A new species is described, *Exoascus aesculi* (Ell. and Ev.) Patterson on *Aesculus californica* Nutt. A footnote by A. B. Seymour tells of the identification by Sadebeck of a new species on *Ostrya virginica,* and this fungus is here described by Patterson under the name *Taphrina virginica* Sadeb. and Seym. (See 93.)

Some species and hosts new to America are recorded, and the fungus on *Populus tremuloides* Michx., *P. grandidentata* Michx., and *P. fremontii* Watson, previously called (56, 59) *Taphrina rhizophora,* is said to be *T. johansonii* Sadeb.

Taphrina extensa (Pk) Sacc., *T. rubrobrunnea* (Pk) Sacc., *T. betulina* Rostr., and *T. lethifera* (Pk) Sacc. are listed as "species inquirendae." *Ascomyces fulgens* Cke. and Hark. is excluded.

93. SADEBECK, R. Einige neue beobachtungen und kritische bemerkungen über die Exoasceen. Bericht. d. Deutsch. Bot. Ges. *13*:265-280. 1895.

The fungus which causes yellow, swollen spots on the carpels of *Populus tremula* L. is said to be *Exoascus johansonii* Sadeb. This fungus also occurs in North America on *Populus tremuloides* Michx. Whether the American form on *Populus fremontii* Watson and *P. grandidentata* Michx. belongs to this species or to *E. rhizophorus* Johans. cannot be decided without material.

An account is given of the life history of *E. johansonii* and of the histology of the diseased host parts.

Schröter's (81) classification of the genus on the basis of spore number is criticised, it being pointed out that even in species with normally eight-spored asci the spores may multiply by budding in the young asci.

Two new species are described: *Taphrina virginica* Seym. and Sadeb., occurring on leaves of *Ostrya virginica* Willd. in North America; and *Magnusiella fasciculata* Lagerh. and Sadeb. on leaves of *Nephrodium* sp. from South America.

A revised classification of the family and list of species is given:

1. Exoascus Fuckel.
   A. Mycelium perennial in inner tissues of stems.
2. Taphrina Fries.
   A. Mycelium and hymenium subcuticular (Eutaphrina).
      a. Fertile hyphae completely used up in formation of asci. (Nine species.)
      b. Fertile hyphae not completely used up in forming asci. (Three species.)
   B. Mycelium and hymenium within epidermal cells (Taphrinopsis). (One species.)
3. Magnusiella Sadebeck. (Six species.)

94. GIESENHAGEN, K. Die entwickelungsreihen der parasitischen Exoasceen. Flora *81*:267-361. 1895.

In this paper Giesenhagen, who accepts Sadebeck's genus Magnusiella but would unite all other forms into one genus, Taphrina, criticises attempts of preceding authors to subdivide this genus. Brefeld's (74) separation into Exoascus with four spores is not possible because the researches of Atkinson (86) and Sadebeck have shown that in several species the asci may be sometimes four-spored and sometimes eight-spored. Tulasne's (14) classification, followed by Schröter (81) of eight-spored forms as Exoascus and many-spored forms as Taphrina, is also impossible, since, as shown by Sadebeck (73, 80), Johanson (56), and Rostrup (71), eight-spored forms may become many-spored by budding of the spores within the ascus. Sadebeck's points of distinction between Exoascus and Taphrina are also criticised. Giesenhagen does not consider the possession or lack of perennial mycelium a good basis of generic distinction, since it is not so used with higher plants. As to the further distinction used by Sadebeck, the presence or absence of sterile cells between the asci, he points out that in *Taphrina betulae*, for example, the mycelium being only subcuticular, such sterile cells as occur must be among the ascogenous cells, while in *T. cerasi* (Sadebeck's Exoascus), with intercellular mycelium, branches grow up from these sterile cells to form the subcuticular hymenium. What this amounts to is that in the one case both the sterile and fertile mycelium are beneath the cuticle, in the other the sterile mycelium is deeper in the leaf and the fertile beneath the cuticle. These differences are essentially differences in life history and with old material might be difficult to determine.

Sadebeck's genus Magnusiella is like Exoascus except that branches grow up between epidermal cells to form asci without developing a subcuticular mycelium.

A strict interpretation of the characters of Magnusiella will cause the removal of *M. flava* from that genus, since it has both a subepidermal and a subcuticular hymenium. This fungus thus becomes *Taphrina flava* Farl.

Giesenhagen recognizes four types among the Taphrinaceae, based on the shape of the ascus. These are: 1. The Filicina type with slender asci, narrowed above and below; 2. The Betula type, with cylindric asci, more or less truncate at the apex; 3. The Pruni type, with clavate or cylindric asci, often rounded at the apex; 4. The Magnusiella type, with ovate or elliptic asci. Forty-six species may be readily distributed among these four types. Seven species: *T. alni-incanae, T. johansonii, T. rhizophora, T. carpini, T. kruchii, T. caerulescens, T. purpurascens*, cannot be fitted into any of these types unless the base of the ascus is in these forms considered the equivalent of a stalk cell and the shape of the ascus determined from the ascus proper. It is then found that the first three of these species fit well into the Betula type and the others less perfectly into the same type.

Forms, within the Betula type, with or without the stalk cell are similar and differ only in the presence or absence of a septum in the basal part of the ascus.

Further examination of the host relationships of the three types of Taphrina reveals the following: Type 1 (Filicina) is confined to ferns. Type 2 (Betula) to Amentiferae, Type 3 (Pruni) to Rosaceae. On basis of host-

relations a fourth type may be distinguished, the Aesculi type on Eucycleae. These four types are thought to be four evolutionary races. The Filicina race is considered the oldest because least related to the others. The Betula race is the largest and contains groups distinguishable by presence or absence of stalk cell and intercellular or subcuticular habit of mycelium.

A discussion of geographic distribution of known species is given and a list with careful descriptions of the forty-nine species of Taphrina and two of Magnusiella.

Taphrina aurea may or may not have a stalk cell. Examination of herbarium material (Ellis and Everhart No. 1887) shows that *T. aesculi* has a stalk cell contrary to the report of Patterson (92) that it has not. Patterson's report of no stalk cell in the form on fruits of *Alnus incana, A. serrulata,* and *A. rubra* must mean, if true, that *T. alni-incanae* occurs in North America, as well as *T. robinsoniana,* or else that the latter species is, like *T. aurea,* variable as to the possession of a stalk cell.

The species reduced to synonymy by Giesenhagen are: *Exoascus campestris* Sacc., *E. aemiliae* Passer., *E. flavus* Sadeb., *E. varius* Atk., *Ascomyces quercus* Cke., *A. alutaceus* Thm., *E. aceris* Linh. Species excluded are: *Ascomyces fulgens* Cke., *Taphrina candicans* Sacc., and *T. juglandis* Berk. One new species is described, *Taphrina robinsoniana* Giesenhag. on fruits of *Alnus incana* Willd. in North America. (Ellis, North American Fungi No. 796.)

95. SADEBECK, R. Ueber das auftreten und die verbreitung einiger pflanzenkrankheiten in östlichen alpengebiete, namentlich in Tirol. Forstl. Naturw. Zeitschr. *4*:82-88. 1895.

From observations of the occurrence of *Taphrina ostryae* Massal. on the lower leaves only of large trees decides that this fungus does not possess perennial mycelium.

96. SHIRAI, M. (On witches' brooms of Prunus pseudocerasus.) Bot. Mag. (Tokyo) *9*:161-164. 1895.

In Japanese. Species diagnosis in English. Describes a new species, *Taphria pseudocerasus* Shirai, on *Prunus pseudocerasus* Lindl., and *P. miquelliana* Maxim. (*P. subhirtella Miq.*) in Japan.

97. STEWART, F. C. Witches' brooms on cherry tree. New York Agric. Exp. Sta. Ann. Rept. *14*:532-533. 1896.

Reports the occurrence of *Taphrina cerasi* (Fkl.) Sadeb. on *Prunus avium* L. on Long Island. The only previous report of this fungus in North America was that by Meehan (54).

98. STURGIS, W. C. A leaf curl of the plum. Connecticut Agric. Exp. Sta. Ann. Rept. *19*:183-185. 1896.

Describes a disease of a cultivated variety of Japan plum (*Prunus triflora* Roxb.) caused by a fungus which is identified as *Exoascus mirabilis* Atk.

99. THOMAS, F. Ueber einige Exobasideen und Exoasceen. Forstl. Naturw. Zeitschr. *6*:305-314. 1897.

Describes a new species, *Exoascus janus* Thomas., on *Betula verrucosa* Ehrh. Suggests that this fungus, *T. bacteriosperma* Johans. and *T. carnea* Johans., may be biologic forms of a single species.

100. DERSCHAU, D. VON. Ueber Exoascus deformans. Ein beitrag zur entwickelungsgeschichte des parasiten. Landw. Jahrb. *26*:897-901. 1897.

Reports the occurrence of *Taphrina deformans* on the flower of the peach. Gives notes on varietal resistance of peaches to *T. deformans* and of plums to *T. pruni*. Reports observing infection of detached peach leaves by *T. deformans*, the mycelium entering a stoma.

101. SCHRÖTER, J. Protodiscineae. In Engler, A., and K. Prantl., Die Naturlichen Pflanzenfamilien. *1*: 1:156-161. 1897.

Gives the following classification of the family Exoascaceae:

1. Asci formed on the ends of branches of the intercellular mycelium. *Magnusiella.*
2. Asci from a subcuticular hymenium.
   a. Asci eight (rarely four) spored. *Exoascus.*
   b. Asci becoming many-spored by budding of the spores. *Taphria.*

102. PECK, C. H. Report of the Botanist. New York State Mus. Nat. Hist. Ann. Rept. *51*:267-312. 1898.

Describes a new species, *Exoascus unilateralis* Pk. on leaves of *Prunus virginiana* L.

103. DUGGAR, B. M. Peach leaf-curl and notes on the shot hole effect of peaches and plums. Cornell Univ. Agric. Exp. Sta. Bull. 164. 1899.

An account of the peach leaf-curl disease. Spraying experiments indicate that infection is due to overwintering spores.

104. GIESENHAGEN, K., Ueber einige pilzgallen an farnen. Flora *86*:100-109. 1899.

Describes a new species, *Taphrina fusca* Giesenhag. on *Aspidium pallidum* Lk. Also describes *T. filicina* Rostr. on *Aspidium spinulosum* (O. F. Müll) Sw.

105. PIERCE, N. B., Peach leaf-curl: its nature and treatment. U. S. Dept. Agric. Div. Veg. Phys. and Path. Bull. 20. 1900.

The classical paper on the control of peach leaf-curl and on the life history of *Taphrina deformans.*

106. RITZEMA BOS, J. Over krulloten en heksenbesems in de cacaoboomen Suriname en einige opmerkingen over heksenbesems in t'algemeen. Tijdschr. over Plantenziekt. *6*:65-90. 1900.

Describes a witches' broom of *Theobroma cacao* L. from Surinam. Found a few asci present, but could not, on account of the state of the material, describe the fungus. Nevertheless names it as a new species, *Exoascus theobromae* Ritzema Bos.

A paper by the same author in Zeitschr. f. Pflanzenkr. *11*:26-30. 1901, is essentially a duplication of the above.

107. SCALIA, G. I funghi della Sicilia Orientale e principalmente della regione Etnea. Atti dell. Accad. Gioenia di Scienge naturale in Catania. (Ser. IV.) *13*: XX: 1-55. 1900.

Reports (inter alia) occurrence of *Taphrina deformans* on the almond, *Prunus communis* Fritsch.

108. GIESENHAGEN, K. Taphrina, Exoascus and Magnusiella. Bot. Zeit. *59*:115-142. 1901.

This paper reviews the earlier literature and presents an exhaustive bibliography. It also gives Giesenhagen's final views as to the classification of the Exoascales. He points out that Sadebeck's Exoascus is not the Exoascus of Fuckel, and would contain only half of the species described by Fuckel, the others falling in Sadebeck's Taphrina.

As an example of the way in which Sadebeck's classification separates related species he cites *Taphrina caerulescens, T. kruchii, T. aurea, T. johansonii,* and *T. rhizophora.* According to Sadebeck the second, fourth, and fifth of these would be called Exoascus.

Giesenhagen finds Sadebeck's distinction with regard to sterile and fertile mycelium very difficult to determine without an abundance of material and therefore impractical as a basis of separating genera.

He accepts the genus Magnusiella, but recognizes but one other genus, which on the basis of priority must be called Taphrina.

He again compares the ascus-form of the species (including the new *T. vestergrenii*) belonging to his Filicina-race, and reiterates his former view that ascus-form and host-relationships form the best basis for classification within the genus.

He divides Taphrina into subgenera on the basis of his earlier classification, the Filicina-race becoming Taphrinopsis, the Betula-race Eutaphrina, the Pruni-race Euexoascus, and the Aesculi-race Sadebeckiella.

He presents a synopsis, with chief distinguishing characters, of the forty-nine known species of Taphrina and five of Magnusiella, and an alphabetically arranged host index. In Magnusiella he includes, besides the two previously (93) given, *M. fasciculata* Lagerh. and Sadeb. on *Nephrodium* sp., *M. lutescens* Sadeb. on *Aspidium thelypteris* Roth., and *M. potentillae* Sadeb. on *Potentilla silvestris* Neck., *P. canadensis* L., and *P. geoides* M. B.

Giesenhagen also describes a new species, *Taphrina vestergrenii* Giesenhag. on *Aspidium filix-mas* Sw., and describes and figures spore-bearing asci for *T. laurencia.*

109. IKENO, S. Studien über die sporen bildung bei Taphrina Johansoni Sad. Flora *88*:229-231. 1901.

Describes a form occurring on fruits of *Populus tremula* L., var. *villosa* Wesm. whose asci are intermediate between those of *T. rhizophora* Johans. and *T. johansonii* Sadeb. On the basis of the host and the apparent lack of rhizoidal extensions of the base of the ascus decides to call this fungus *T. johansonii.* Gives an account for this species of nuclear fusion in the young ascus, division (not by typical mitosis) of the fusion nucleus and daughter nuclei, and of spore formation.

110. JAAP, O. Ein kleiner beitrag zur pilzflora von Tirol. Deutsche bot. Monatschr. *19*:75-76. 1901.

Names, on the authority of Magnus, a new species, *Exoascus viridis* Sadeb. in litt. ad Magnus, occurring on *Alnus viridis* DC. No description is given. Information from Magnus is that the fungus had been collected some years previously by Sadebeck.

111. JACZEWSKI, A. (Exoasci of Caucasus.) Bull. Jard. Imp. Bot. St. Petersburg. *1*:7-13. 1901.

In Russian. Lists (with description) thirty-three species occurring in the Caucasus. Describes a new species, *Exoascus confusus* Jacz. on *Acer campestris* L. This name had been previously used by Atkinson (86) for a species occurring on *Prunus virginiana* L.

112. REHM, H. Beiträge zur Pilzflora von Südamerika. Hedwigia *40*:141-170. 1901.

Describes a new species, *Taphrina randiae* Rehm, on *Randia* sp. from Brazil.

113. HENNINGS, P. Fungi costaricenses I. Beiblatt zur Hedwigia *41*:101-105. 1902.

Describes a new species, *Taphrina tonduziana* Henn. on *Pteris aculeata* Sw.

114. JUEL, H. O. Taphridium Lagerh. and Juel, eine neue gattung der Protomycetaceae. Bihang t. K. Vetensk. Akad. Handl. *27*:3-29. 1902.

Removes *Taphrina umbelliferarum* Rostr. and *T. oreoselini* Massal. from the Taphrinaceae, placing them in the new genus Taphridium, of the Protomycetaceae.

115. SVENDSEN, C. J. En ny Taphrina paa Betula alpestris. Nyt. Mag. f. Naturvidensk. *40*:363-368. 1902.

Describes a new species, *Taphrina willeana* Svends. on *Betula alpestris* Fries.

116. VOLKART, A. Taphrina rhaetica nov. spec. und Mycosphaerella aronici (Fuck.). Bericht. d. d. Bot. Ges. *21*:477-481. 1903.

Describes a new species, *Taphrina rhaetica* Volk. on leaves of *Crepis blattarioides* Vill. This fungus cannot be placed in Magnusiella, since it possesses an hymenium. This hymenium being subepidermal is not like Taphrina. However, since Taphrina already includes one atypical species, *T. laurencia* Giesenhag., in which the hymenium is found within the epidermal cells of the host, the new fungus is placed in that genus. Some resemblance exists between this fungus and *Taphridium umbelliferarum* (Rostr.) Lagerh. and Juel, but since it has unmistakable asci, and these and the ascogenous cells are not multinucleate from the beginning it cannot belong to that genus.

117. SADEBECK, R. Einige kritische bemerkungen über Exoasceen. I. Ber. d. Deutsch. Bot. Ges. *21*:539-546. 1903.

Decides that both *Taphrina rhaetica* Volk. and *Magnusiella potentillae* (Farl.) Sadeb. really belong in Exoascus. They both possess a subepidermal hymenium. Although Sadebeck (80) had previously stated that *M. potentillae* had no hymenium, he now agrees with Johanson (52) that it forms one beneath the epidermis.

A discussion is given of the variations in form of asci found within the same species. This is in refutation of Giesenhagen's (94) claim that races of Taphrina distinguished on the basis of ascus-form may be correlated with host-races.

A new statement is made of the generic characters of Exoascus and Taphria, (which he now prefers on basis of priority to Taphrina) as follows:

Exoascus. Mycelium falls apart oidium-like. Oidia form a hymenium, and either directly or after further division become ascogenous cells. Mycelium perennial.

Taphria (Taphrina). Mycelium does not fall apart oidium-like. Fertile hyphae form, after differentiation of material, on ends and on side branches of mycelial threads.

118. IKENO, S. Die sporenbildung von Taphrina arten. Flora *92*:1-31 1903.

Describes a new species, *Taphrina kusanoi Ikeno.*, on leaves of *Pasania euspidata* Oerst. Gives an account of the cytology of this and the following species: *T. johansoni* Sadeb., *T. cerasi* (Fkl.) Sadeb., *T. pruni* (Fkl.) Tul., *T. deformans* (Berk.) Fkl., and a new variety of the last named fungus, called *T. deformans* (Berk.) Fkl. var. *armeniaca* Ikeno. Describes nuclear fusion in ascogenous cells, division of the fusion nucleus (by mitosis in *T. cerasi* and *T. pruni*) to form the spore nuclei, formation of the spores with surviving epiplasm, and (in some cases) septation of the ascus to form a basal cell.

119. HENNINGS, P. Fungi fluminensis A. cl. E. Ule collecti. Hedwigia *43:* 78-95. 1904.

Describes a new species, *Exoascus uleanus* P. Henn. on *Pteris decurrens* Presl., from Rio de Janeiro.

120. SADEBECK, R. Einige kritische bemerkungen über Exoascus sebastianae nov. spec. Ber. d. Deutsch. Bot. Ges. *22:* 119-133. 1904.

Describes a new species, *Exoascus sebastianae* Sadeb. on *Sebastiana brasiliensis* (Mull.) Arg. from Brazil. An atypical species.

121. WENT, F. A. F. C. Krulloten en versteende vruchten van de Cacao in Suriname. Verhandel. d. Koninkl. Akad. v. Wetensch. te Amsterdam. Tweede Sectie. *10:* 3-40. 1904.

Reports a careful study of the witches' broom disease of cacao previously described by Ritzema Bos (106). Mycelium was found but no fruiting structures, and it is left uncertain whether this disease may be due to a species of Taphrina.

122. HEINRICHER, E. Exoascus cerasi (Fuckel) Sadeb. als günstiger rapräsentat hexenbesen bildender pilze für pflanzenbiologische gruppen. Naturw. Zeitschr. Forst. und Landw. *3:* 344-348. 1905.

Reports successful grafting of witches' brooms (*Taphrina cerasi* (Fkl.) Tul.) into healthy cherry trees, also the failure of Peyritsch to produce infection with spores.

123. JAAP, O. Beiträge zur Pilzflora von Mecklenberg. Ann. Mycol. *3:* 391-401. 1905.

Lists several species. A new host, *Alnus glutinosa* × *incana* Krause (*A. hybrida* A. Br.) is reported for *Taphrina alni-incanae* (Kühn) Magn.

124. KUSANO, S. New species of Exoascaceae. Bot. Mag. (Tokyo). *19:* 1-5. 1905.

Describes three new Japanese species: *Taphrina truncicola* Kus. on *Prunus incisa* Thunb., *T. piri* Kus. on *Pyrus miyabe* Sargent, and *T. japonica* Kus. on *Alnus japonica* S and Z.

125. KUSANO, S. Einige neue Taphrina-Arten aus Japan. Ann. Mycol. *3:* 30-31. 1905.

Repeats his descriptions of the three new species mentioned above.

126. NEGER, F. Exoascaceae. In Hennings, P., G. Lindau, P. Lindner and F. Neger. Kryptogamenflora der Mark Brandenburg. *7:* 35-73. 1905.

A comprehensive account of the family, recognizing Giesenhagen's classification, and including a taxonomic treatment of the twenty-two species found in the province of Brandenburg.

127. YOSHINO, K. A list of the fungi found in the province of Higo. Bot. Mag. (Tokyo) *19:* 199-222. 1905. (In Japanese.)

Lists six species of Taphrina found in Japan. Of these two new species are named: *T. hiratsukae* Nishida on *Onoclea* sp., and *T. mume* Nishida on *Prunus armeniaca* L. var. *ansu* Maxim.

The descriptions of the above species are to be found in the later paper by Nishida (140).

128. BUBAK, F. Zweiter beitrag zur pilzflora von Montenegro. Bull. del Herbier Boissier Ser. 2, *6:* 393-408, 473-488. 1906.

Describes a new species, *Taphrina moriformis* Bubak on *Aspidium rigidum* Sw.

129. FABER, F. VON. Bericht über die pflanzenpathologische expedition nach Kamerun. Tropenpflanzer. *11:* 755-775. 1907.

Names a new species, *Exoascus bussei* v. Fab., on *Theobroma cacao* L.

130. KUSANO, S. A new species of Taphrina on Acer. Bot. Mag. (Tokyo) *21:* 65-67. 1907.

Describes a new species, *Exoascus nikkoensis* Kus. on *Acer purpurascens* Fr. and Sav. The ascus has a basal cell, otherwise this species seems close to *A. lethifer* Pk. and *T. polyspora* (Sorok.) Johans.

131. FABER, F. C. VON. Untersuchungen über krankheiten des Kakaos. I. Uber den hexenbesen der kakaobäume in Kamerun. Arb. aus der Kaiserl. Biolog. Anstalt für Land-und Forstwirtsch. *6:* 385-395. 1908.

Describes a new species *Taphrina theobromae* Fab. (see 129) causing a witches' broom of *Theobroma cacao* L. in Kamerun. Gives an account of the morphology and anatomy of the witches' broom. Believes it distinct from the disease of cacao described by Ritzema Bos (106) as occurring in Surinam, and declares the binomial *Exoascus theobromae* Ritzema Bos to be a nomen nudum.

132. CONNOLD, E. T. Plant galls of Great Britain. London, Adler. 1909, p. 117.

Figures and describes a witches' broom on *Corylus avellana* L. as due to *Exoascus Avellanae* Con. No evidence is presented that this deformation is due to a fungus and the binomial was later declared by Saccardo (vol. 24, 1301) to be a nomen nudum.

133. JUEL, O. Om Taphrina-Arter på Betula. Svensk. Bot Tidskr. *3:* 183-191. 1909.

Lists, with descriptions and some discussion of relationships, nine species of Taphrina occurring on Betula in Sweden.

134. PALM, B. Taphrina andina n. sp. Svensk Bot. Tidskr. *3:* 192-195. 1909.

Describes a new species, *Taphrina andina* Palm, on leaves of *Prunus salicifolia* HBK.

135. COKER, W. C. A new host and station for *Exoascus filicinus* (Rostr.) Sacc. Mycologia *2:* 247. 1910.

Reports occurrence of *Taphrina filicina* Rostr. on *Dryopteris acrostichoides* Kuntze (*Polystichum acrostichoides* (Michx.) Schott).

136. HERZFELD, S. Ueber eine neue Taphrina auf Polystichum Lonchitis. Oesterr. Bot. Zeitschr. *60:* 249-254. 1910.

Describes a new species, *Taphrina wettsteiniana* Herzf. on *Polystichum lonchitis* (L.) Roth.

137. MAIRE, R. Contribution à l' etude de la flore mycologique des Alpes-Maritimes. Champignons récoltes à la session de Saint-Martin-Vésubie (1910). Bull. Soc. Botanique de France. 4 ser. *10:* CLXVI-CLXXVI. 1910.

Describes a new species, *Taphrina viridis* (Sadeb.) Maire on *Alnus viridis* DC. This fungus was previously named *Exoascus viridis* Sadeb. by Jaap (110) but no description was given. It was also distributed in Vestergren, Micromycetes Selectae Exsiccati No. 720. 1903, as *Taphrina alnastri* Lagerh.

138. THAXTER, R. Notes on Chilean fungi. I. Bot. Gaz. *50:* 435. 1910.

Describes a new species, *Taphrina entomospora* Thaxt., on *Nothofagus antarctica* Oerst. from Punta Arenas, Chile.

139. BUTLER, E. J. The leaf spot of Turmeric (Taphrina maculans sp. nov.) Ann. Mycol. *9*: 36-39. 1911.

Describes a new species, *Taphrina maculans* Butl. on *Curcuma longa* L., and *Zingiber casumunar* Roxb. The fungus grows in the radial walls of the epidermal and hypodermal cells, but in the intercellular spaces of the mesophyll. It is unique among the Taphrinaceae in possessing haustoria.

140. NISHIDA, T. A contribution to the monograph of the parasitic Exoascaceae of Japan. Miyabe-Festschrift. Tokyo 1911. pp. 157-212. In Japanese. English Summary, pp. 205-212.

Gives descriptions, with notes on occurrence of twenty-five species of Taphrina found in Japan. New species are as follows: *Taphrina struthiopteridis* Nish. on *Struthiopteris germanica* Willd. (*Matteuccia struthiopteridis* Tod.), *T. hiratsukai* Nish. on *Onoclea sensibilis* L., *T. osmundae* Nish. on *Osmunda regalis* L. var. *japonica* Willd., *T. coryli* Nish. on *Corylus heterophylla* Fisch. and *C. rostrata* Ait. var. *sieboldi* Maxim., *T. betulicola* Nish. on *Betula ermanni* Cham. var. *nipponica* Maxim., *T. alni-japonicae* Nish. on *Alnus japonica* S. and Z., *T. mume* Nish. on *Prunus mume* S. and Z., and *P. armeniaca* L. var. *anzu* Maxim. Species recorded on new hosts are as follows: *T. caerulescens* on *Quercus dentata* Thunb., *Q. crispula* Bl., *Q. grosserata* Bl., *Q. glandulifera* Bl., *Q. serrata* Thunb.; *Q. glauca* Thunb.; *T. bullata* on *Pyrus sinensis* Lindl.; *T. cerasi* on *Prunus pseudocerasus* Lindl. var. *spontanea* Maxim., and var. *sieboldii* Maxim., *P. miqueliana* Maxim.; *T. pruni* on *Prunus tomentosa* Thunb., and *P. incisa* Thunb.; *T. farlowi* on *Prunus ssiori* Fr. Schm.; *T. truncicola* Kus. on *Prunus maximowiczii* Rupr.

This list of species includes *Magnusiella umbelliferarum* (Rostr.) Sadeb., which is actually *Taphridium umbelliferarum* (Rostr.) Lagerheim and Juel. The number of Taphrinas described is therefore twenty-four.

141. SYDOW, P., and E. J. BUTLER. Fungi Indiae Orientalis. III. Ann. Mycol. *9:* 372-421. 1911.

Report occurrence of *Taphrina deformans* (Berk.) Fkl. on peach, *E, pruni* Fkl. on fruits of *Prunus padus* L., *T. aurea* Fr. on leaves of *Populus ciliata* Wall., *T. maculans* Butl., on leaves of *Curcuma longa* L., *C. amadae, C. angustifolia* Roxb., *Zingiber casumunar* Roxb., *Zingiber zerumbet* Roscoe.

Describes a new species, *T. rhomboidalis* Syd. and Butl. on leaves of *Pteris quadriaurita* Retz. Apparently another species occurs on this host in Ceylon and Assam.

142. JUEL, H. O. Beiträge zur kenntnis der gattungen Taphrina und Exobasidium. Svensk. Bot. Tidskr. *6:* 353-372. 1912.

Notes on the various species of Taphrina found on Betula in Lapland. A description is given of a new species, *Taphrina lapponica* Juel. on *Betula odorata* Bechst. Also a new variety, *T. nana* Johans. var. *hyperborea* Juel, on the same host. *T. bacteriosperma* Johans. was found on a new host, *Betula nana* L.

143. LAUBERT, R. Einige pflanzenpathologische beobachtungen. Zeitschr. f. Pflanzenkr. *22:* 449-454. 1912.

Describes a witches' broom of *Prunus acida* (Dum.) K. Koch, very similar to the one previously described by Sadebeck (73) as caused by *Taphrina minor* on *Prunus chamaecerasus* Jacq. (*Prunus fruticosa* Pall.). It is suggested that Sadebeck's host may have been *P. acida.* Morphologically the fungus on *P. acida* agrees well with either *T. minor* or *T. cerasi* and it seems possible that these two species are not well distinguished.

144. KUSCHKE, G. Mycoflorae caucasicae novitates. Moniteur du Jard. Bot. Tiflis. *31:* 23-27. 1913.

Describes a new species, *Exoascus cerasi-microcarpi* Kuschke, on *Cerasus microcarpa* Boiss. (*Prunus microcarpa* C. A. Mey.) The article is in Russian, but a Latin diagnosis is given.

145. CLINTON, G. P. Notes on plant diseases of Connecticut. Report of the Station Botanist, for 1913. Connecticut Agric. Exp. Sta. Rept. *1914* Part I: 1-30. 1914.

Records a case of *Taphrina deformans* attacking the fruit of the peach.

146. SYDOW, H., and P. SYDOW. Diagnosen neuer philippinischer pilze. Ann. Mycol. *12:* 545-576. 1914.

Describes a new species, *Taphrina linearis* Sydow on *Globba marantina* L.

147. SCHELLENBERG, H. C. Zur kenntnis der winterruhe in den zweigen einiger hexenbesen. Ber. d. Deutsch. Bot. Ges. *33:* 118-126. 1915.

Notes a shortening of the winter rest period in buds of witches' brooms caused by *Taphrina cerasi* and *T. turgida.* Believes little or no carbon assimilation occurs in leaves of witches' brooms.

148. HEINRICHER, E. Zur frage nach der assimilatorischen leitungsfähigkeit der hexenbesen des kirschbaumes. Ber. d. Deutsch. Bot. Ges. *33:* 245-253. 1915.

An account of experiments which show higher osmotic pressure and more carbon assimilation in tissues of the cherry witches' broom (*Taphrina cerasi*) than in healthy tissues.

149. SCHMITZ, H. Some observations on witches' brooms of cherries. Plant World. *19:* 239-242. 1916.

Notes higher osmotic pressure, rich food content and presence of anthocyans in tissues of witches' brooms caused by *Exoascus cerasi.* Similar observations were made on a witches' broom found on *Prunus emarginata* Walp.

150. DEARNESS, J. New or noteworthy North American fungi. Mycologia *9:* 345-364. 1917.

Describes a new species, *Exoascus aceris* Dearn. and Barth. on *Acer grandidentatum* Nutt.

151. JAAP, O. Weitere beiträge zur pilzflora der Schweiz. Ann. Mycol. *15:* 97-124. 1917.

Lists twelve species of Taphrina as occurring in Switzerland. Raises *T. polyspora* Sorok. var. *pseudoplatani* Massal. to specific rank as *T. pseudoplatani* (Massal.) Jaap.

152. PALM, B. Svenska Taphrinaarter. Arkiv. för Botanik. *15:* 1-41. 1917.

Describes the following new species: *Taphrina lata* Palm, *T. lagerheimi* Palm, and *T. splendens* Palm on *Betula odorata* Bechst., *T. media* Palm on *Alnus glutinosa* Medic. Raises *T. betulae* (Fkl.) Johans. var. *auctumnalis* Sadeb. to specific rank as *T. auctumnalis* (Sadeb.) Palm. Renames *Exoascus confusus* Jaczewski as *Taphrina jaczewski* Palm, since the specific name used by Jaczewski (111) had already been employed by Atkinson (86) for another fungus. Lists, with keys and descriptions, thirty-five species as occurring in Sweden.

153. SYDOW, H., and P. SYDOW. Beitrag zur kenntnis der pilzflora der Philippinen Inseln. Ann. Mycol. *15:* 165-268. 1917.

Report the occurrence in the Philippines of *Taphrina maculans* Butl. on *Zingiber zerumbet* Roscoe.

154. SWINGLE, D. B., and H. E. MORRIS. Plum pocket and leaf gall on Americana plums. Montana Agric. Exp. Sta. Bull. 123. 1918.

An account of plum pockets caused by *Taphrina communis* on cultivated varieties of *Prunus americana.* Perennial mycelium is believed to be of rare occurrence. The ascospores are uninucleate but preliminary to conidium formation the nucleus divides to two or even several nuclei.

155. SIEMASZKO, W. Fungi caucasici novi vel minus cogniti. Bull. Musee du Caucase. *12:* 20-28. 1919.

Describes a new species, *Taphrina struthiopteridis* Siem. on *Matteuccia struthiopteris* Todaro.

156. SYDOW, H., and P. SYDOW. Novae fungorum species. XVI. Ann. Mycol. *18:* 154-160. 1920.

Describe a new species, *Taphrina mexicana* Syd. on leaves of *Prunus microphylla* Hemsl. in Mexico.

157. JUEL, H. O. Cytologische pilzstudien. II Zur kenntnis einiger Hemiasceen. Nov. Act. Reg. Soc. Sci. Upsal. Ser 4, *5:* 3-41. 1921

This paper contains an account of the cytology of several species of Taphrina.

In *T. pruni* and *T. rostrupiana* cells of the mycelium contain two closely paired nuclei. The young ascus has one nucleus. The first division of this nucleus may be a reduction division. Two divisions follow. Spores form around the eight nuclei in a layer of cytoplasm next the ascus-walls, the interior of the ascus being empty. A small amount of epiplasm remains after spore formation.

In *T. cerasi* the empty basal cell is formed by vacuolization of the lower part of the chlamydospore (which is what Juel considers the ascogenous cell) and formation of a septum. In *T. bullata* the young cells of the mycelium each contain several pairs of nuclei, old cells contain each one pair.

In *T. potentillae* each ascus-bearing branch of the mycelium contains one pair of nuclei. In the widened end of this branch the nuclei fuse, the widened end elongates to an ascus and the fusion nucleus divides by three successive divisions. In places a local subcuticular layer of ascus-forming hyphae occurs.

In *T. alnitorqua* Tul. chlamydospores are at first binucleate, later the nuclei fuse. Before division of the fusion nucleus all the protoplasm enters the ascus, leaving the chlamydospore empty. This is then cut off by a septum to form a basal cell. The first division of the fusion nucleus was observed.

In *T. sadebecki* nuclear divisions in the ascus were not seen. Formation of the ascus and the basal cell occurs as in *T. epiphylla*.

In *T. epiphylla* young vegetative cells are binucleate. The chlamydospore has a thick membrane; it germinates by the rupture of this wall and the emergence of a thin-walled protoplast, which becomes the ascus. The empty chlamydospore is cut off from the ascus by a wall, thus becoming the basal cell. Nuclear division in the ascus was not observed.

T. betulina differs from the preceding in that in ascus formation the whole wall of the chlamydospore becomes thinner and extended. An empty basal cell is cut off. Three successive nuclear divisions occur in a thin layer of protoplasm next to the ascus wall.

In *T. carnea* the ascus forms as in the preceding. The chlamydospore empties as usual, but no wall forms and there is no separate basal cell. The first division of the ascus nucleus was observed. Ascospores bud within the ascus almost at once. In *T. aurea* young cells of the mycelium have each one pair of nuclei. An apparent telophase of conjugate division was observed. Ascogenous cells are at first binucleate, then the nuclei fuse. Division of the fusion nucleus may be by amitosis. Not all of the eight nuclei may form spores. Spores bud almost at once. Basal cell forms as in other species, but it is very small and may be lacking.

In all of the above species where nuclear division was observed it was mitotic, the figures being intranuclear.

The genus Taphrina is considered by Juel to be closely allied to Taphridium and Protomyces of the Protomycetaceae. The ascogenous cell (as noted above) is considered a chlamydospore. The basal cell of the ascus is a feature of some Taphrinas, the forms lacking it are considered the more primitive.

158. WEDERMANN, E. Taphrina reichei n. sp. ein neuer mexikanischer hexenbesen. Notizbl. d. Bot. Gart. und Mus. in Berlin-Dahlem. *8:* 221-222. 1922.

Describes a new species, *Taphrina reichei* Werd. on *Prunus capollin* Koehne.

159. BECKER, J. Ein beitrag zur züchtung der pfirische. Gartenwelt *27:* 274-275, 285-286. 1923.

Discusses varietal susceptibility of the peach to curl.

160. BRITON-JONES, H. R. Pear leaf blister (Taphrina bullata, Tul.). Univ. Bristol, Agric. and Hort. Res. Sta. Ann. Dept. *1923:* 89-90. 1923.

Reports occurrence of pear leaf blister in many localities in England in 1923. Attack by Taphrina predisposes pear leaves to attack by *Venturia pirina* Aderh., the cause of pear scab. Varieties of pears are listed as to susceptibility to *T. bullata.*

161. CUNNINGHAM, G. H. Leaf-curl, bladder plum and cherry-curl, their appearance, cause and control. New Zealand Jour. Agric. *26:* 85-87. 1923.

Reports occurrence in New Zealand of *Taphrina deformans, T. pruni,* and *T. minor,* with discussion of their life histories and some notes as to varietal resistance.

162. KLEBAHN, H. Infektionsversuche mit Taphrina tosquinetii. Ber. d. Deutsch. Bot. Ges. *41:* 108-113. 1923.

Reports cultivation in artificial media of *Taphrina tosquinetii* (Westend.) Magn., *T. epiphylla* Sadeb., *T. sadebeckii* Johans., *T. aurea* Fr. and *Taphrina* sp. from *Betula pubescens* Ehrh. Inoculation experiments with *T. tosquinetii* were successful, with the other species they failed. It is concluded that *T. tosquinetii* sometimes overwinters as mycelium within the host tissues.

163. MARTIN, E. M. Cytological studies of Taphrina coryli Nishida on Corylus americana. Trans. Wisconsin Acad. Sci., Arts, and Letters. *21:* 345-355. 1924.

An account of the cytology of this species. The vegetative cells and the young ascogenous cells are binucleate. Nuclear fusion occurs in ascogenous cells. The fusion nucleus divides by reduction division, a cleavage furrow and then a septum cuts off a basal cell from the young ascus. The basal cell and the ascus each receive one of the daughter nuclei, but that in the basal cell soon degenerates. The ascus-nucleus divides by three successive divisions to form the nuclei for the spores. The bud-conidia are uninucleate.

164. MIX, A. J. Biological and cultural studies of Exoascus deformans. Phytopath. *14:* 217-233. 1924.

This paper reports studies of the behavior of *Taphrina deformans* in artificial culture, successful inoculations, and experiments and observations on the life history of this fungus.

165. CAMPBELL, W. G. Note on an Exoascus disease on *Prunus amygdalus* var. *amara.* Trans. and Proc. Bot. Soc. Edinburgh. *29: 2:* 186-191. 1925.

This is an account of the morphology and life history of a fungus attacking *Prunus amygdalus* Stokes (*P. communis* Fritsch), var. *amara* Hort. and var. *dulcis* Hort., also of the pathological changes induced by it in the former host. Evidence is presented that mycelium over-winters in the phloem. The fungus differs from *Taphrina deformans* (Berk) Fkl. in the absence of a basal cell of the ascus, and in size of asci and of spores. It is considered to be a variety of that fungus.

166. EFTIMIU, P. Sur l'Exoascus deformans (Berk.) Fuck. Compt. Rend. Acad. Sci. Paris *181:* 1085-1087. 1925.

This paper gives an account of the cytology of *T. deformans* and of the pathological changes induced in the host tissues. The findings are reported in detail in a subsequent paper (174) by the same author.

167. MARTIN, E. M. Cultural and morphological studies of some species of Taphrina. Phytopath. *15:* 2: 67-76. 1925.

Reports brief cultural studies of *Taphrina johansonii T. communis, T. mirabilis, T. deformans,* and *T. caerulescens.* Claims successful inoculation on bur oak with *T. caerulescens.*

168. MARTIN, G. H. Diseases of forest and shade trees, ornamental and miscellaneous plants in the United States in 1923. Plant Disease Reporter. Supplement 37. 1925.

On pages 371-373 is an account, supplied by Dr. A. E. Jenkins, of the various species of Taphrina known to occur in America on *Acer* spp. These are: a species very similar to *T. accricola* Massal. on *Acer saccharum* Marsh. and *A. nigrum* Michx., an undescribed species on *A. dasycarpum* Ehrh. (*A. saccharinum* L.), another on *A. rubrum* L., and the previously recorded *T. lethifer* (Pk.) Sacc., and *E. aceris* Dearn. and Barth.

Other notes on the occurrence of Taphrinas in America are found in this paper.

169. MIX, A. J. Biological and cultural studies of *Exoascus mirabilis.* Phytopath. *15:* 4: 214-232. 1925.

Cultural studies and observations on the life history of *Taphrina mirabilis* (Atk.) Giesenhag. on *Prunus angustifolia* Marsh.

170. JACZEWSKI, A. A. (Pocket key for the determination of fungi. Part first. Exoascales.) In Russian. A. A. Jaczewski Mycol. Lab. State Inst. of Exper. Agric. Leningrad. 1926.

This is the latest monographic treatment of known species of Taphrina. The genera of Sadebeck are recognized: Exoascus, with forty-seven species, and Taphrina, with fifty-three. *Taphrina entomospora* Thaxt. is treated as the type of a third genus as proposed by Saccardo (*22:* 765) becoming *Entomospora antarctica* (Thaxt.) Sacc.

The following species, excluded by previous authors, are recognized: *Taphrina cissi, T. fulgens, T. extensa,* and *T. flavo-aurea.* A variety of *T. deformans* on *Prunus amygdalus* is raised to specific rank as *Exoascus amygdali* Jacz. [Apparently this is not the same fungus as that described by Campbell (165).] Other new species are *Exoascus pruni-acidae* Jacz. on *Prunus acida* (Dum.) Koch., *E. sorbi* Jacz. on *Sorbus terminalis* Crantz.

The following new varieties are described: *Exoascus pruni* Fkl. var. *padi* Jacz. on *Prunus padus* L., var. *divaricata* Jacz. on *Prunus divaricata* L. (*Prunus pissardi* Carr and Carr), var. *ussuriensis* on *Prunus ussuriensis.*

New hosts are given as follows: for *T. alni-incanae, Alnus serrulata* Willd.; for *T. betulina, Betula carpatica* Waldst, and *B. tortuosa* Led.; for *T. carpini, Carpinus orientalis* Mill.; for *T. crataegi, Crataegus sanguinea* Pall.; for *T. filicina, Athyrium filix-femina* Roth., and *Nephrodium phegopteris;* for *T. insititiae, Prunus divaricata* Led.; for *T. minor, P. microcarpa* C. A. Mey.; for *T. rhizophora, Populus tremula* x *alba* (*P. bachofenii*); for *T. sadebeckii,*

Alnus tinctoria Sarg. (*A. hirsuta* Turcz.), *A. incana* Willd., and *A. incana* var. *sibirica* Spach. (*A. hirsuta* Turcz var. *sibirica* Schneid.); for *T. carnea*, *Betula tortuosa* Led., and *B. gmelini* Bge. (*B. fruticosa* Pall.); for *T. ulmi*, *Ulmus suberosa* Moench (*U. foliacea* Gilib. var. *suberosa* Schneid.).

171. OVERHOLTS, L. O. Mycological notes for 1924. Mycologia *18:* 31-38. 1926.

Reports a species of Taphrina (somewhat different from *T. lutescens*) on *Onoclea sensibilis* L.

172. WEDGWORTH, H. H. Leaf blister of oak. Mississippi State Plant Board. Quart. Bull *6:* 10-12. 1926.

Reports that *Taphrina caerulescens* attacks nearly all native species of oaks, being most severe on *Quercus nigra* L., and *Q. rubra* L., while *Q. phellos* L. shows marked resistance.

173. BOYCE, J. S. Observations on forest pathology in Great Britain and Denmark. Phytopath. *17:* 1-18. 1927.

Reports finding, in Scotland, *Taphrina aurea* Fr. on *Populus generosa* Henry., and *P. laurifolia* Ledeb., as well as on *P. nigra* L.

174. EFTIMIU, P. Contribution a l' etude cytologique des Exoascees. Le Botaniste *18:* 1-154. 1927.

Species studied are *Taphrina aurea* Fr., *T. alni-incanae* (Kühn) Magn., *T. bullata* (Berk.) Tul., *T. deformans* (Berk.) Fkl., *T. betulae* (Fkl.) Tul., *T. pruni* (Fkl.) Tul., *T. crataegi* Sadeb., *T. insititiae* Sadeb.

Cells of young mycelium are plurinucleate or binucleate. Ascogenous cells are binucleate. Fusion of nuclei occurs just before formation of asci. Asci arise by an outgrowth of a papilla from an ascogenous cell. This outgrowth breaks the cuticle and its upper two thirds becomes the ascus, while the lower part forms the empty basal cell. (In *T. alni-incanae* there is no basal cell.) The ascus nucleus forms by three successive divisions the eight nuclei for the ascospores. The first of these divisions is a reduction division, there being four chromosomes in diploid and two in haploid nuclei.

The ascospores germinate by budding within the ascus or after liberation. The bud receives a daughter nucleus from the mother cell, this nucleus by division initiates the binucleate condition in the mycelium.

In the host the parasites induce hyperthrophy and hyperplasia of cells, accompanied by obliteration of intercellular spaces and thickening of cell walls. Chloroplasts become transformed into amyloplasts. At a certain stage starch disappears from the cells, being probably utilized by the fungus. The spherical cytosomes of healthy cells become vesicular or rod-shaped and lose chromatin. *T. aurea* utilizes oil drops in the host cells.

175. RATHBURN-GRAVATT, A. A witches' broom of introduced Japanese cherry trees. Phytopath. *17:* 19-24, 1927.

This is an account of a witches' broom disease on *Prunus lannesiana* Wilson, and *Prunus yedoensis* Mat. growing in Washington, D. C. The fungus on *P. yedoensis* was identified as *Exoascus cerasi* (Fkl.) Sadeb.

176. WIEBEN, M. Die infektion, die myzeluberwinterung, und die kopulation bei Exoasceen. Forsch. auf. d. Geb. d. Pflanzenkr. und d. Immun. im Pflanzenr. *3:* 139-176. 1927.

Reports artificial culture and successful inoculation experiments with *Taphrina tosquinetii* (Westend.) Magnus, *T. epiphylla* Sadeb., and *T. deformans* (Fkl.) Tul. Inoculations failed with *T. aurea* Fr., *T. bullata* (Berk. and Br.) Tul., *T. crataegi* Sadeb., and *T. klebahni* Wieben. Mycelium of *T. epiphylla, T. tosquinetii, T. betulina* Rostr., *T. sadebeckii* Johans., *T. bullata,* and *T. aurea* is perennial and overwinters in the buds. Copulation occurs between sexually different conidia (the eight ascospores are of two sexes) in *T. epiphylla* and *T. klebahni.* The resulting cell puts forth a long spiral tube bearing a pair of nuclei at its tip.

A new species is described: *Taphrina klebahni* Wieben on *Alnus incana* Willd.

177. ZELLER, S. M. Contribution to our knowledge of Oregon Fungi. II. Mycological notes for 1925. Mycologia *19:* 130-143. 1927.

Describes a new species, *Exoascus pruni-subcordatae* Zell. on *Prunus subcordata* Benth. This is considered nearly related to *E. longipes* Atk. and *E. communis* Sadeb.

178. HEINRICHER, E. Uber einen hexenbesen auf *Cydonia japonica.* Ber. d. Deutsch. Bot. Ges. *46:* 198-204. 1928.

Describes a witches' broom on *Cydonia japonica* Hort. (*Chaenomeles lagenaria* Koidz.), which, it is believed, may be due to a Taphrina.

179. JANKOWSKA, K. Zewnetrzniaki polski. Mem Inst. National Polonais d' Econ. Rur a' Pulawy. *9:* 182-215. 1928.

Describes artificial cultivation of *Taphrina sadebeckii* Johans. Describes twenty-eight species occurring in Poland, four of them being reported for the first time.

180. LAUBERT, R. Taphrinaceae (Exoascaceae). In Sorauer, P. Handbuch der Pflanzenkrankheiten *2:* 457-499. 5th edition. Parey. Berlin. 1928.

A comprehensive account of the genus, including a discussion of the important diseases caused by various species. A complete list of species is given, with description of the most important species.

181. SANSONE, F. Una speciale deformazione dei fruitti di mandorlo dovuta ad attaco dell' *Exoascus deformans.* (Berk.), Fuck. Boll. R. Staz. di Pat Veg. N. S. *8:* 291-299. 1928.

Description of the attack of *T. deformans* on the fruit of the almond.

182. SEYMOUR, A. B. Host index of fungi of North America. Cambridge, Mass. 1929.

Lists the species of Taphrina known to occur in North America.

183. FITZPATRICK, R. E. The life history and parasitism of *Taphrina deformans.* Scient. Agric. *14:* 305-326. 1934.

Reports studies on the life history of the peach leaf-curl fungus, including time of infection, method of penetration and nuclear behavior.

184. KOCH, L. W. Studies on the overwintering of certain fungi parasitic and saprophytic on fruit trees. Canadian Jour. of Res. *11:* 190-206. 1934.

Reports isolation of *Taphrina deformans* from the surfaces of dormant peach buds and successful inoculations with the cultures so obtained.

185. POMERLEAU, R. Notes sur le *Taphrina ulmi*. Naturaliste Canadien. *1934:* 305-308.

Occurrence of *Taphrina ulmi* (Fkl.) Tul. in Quebec, presumably on *Ulmus americana* L.

186. MIX, A. J. The life history of *Taphrina deformans*. Phytopath. *25*: 41-66. 1935.

Reports results of several years' investigation of the peach leaf-curl disease.

187. FITZPATRICK, R. E. Further studies on the parasitism of *Taphrina deformans*. Scient. Agric. *15:* 341-344. 1935.

Studies of the effect of temperature on infection of peach leaves by *Taphrina deformans* and on the subsequent development of the disease. The leaf is shown to become more resistant as it matures.

188. JENKINS, A. E. An undescribed species of Taphrina on chinquapin. Mycologia *28:* 31-34. 1936.

Describes a new species, *Taphrina castanopsidis* (Ellis and Ev.) Jenkins, on *Castanopsis chrysophylla* DC.

189. BATAILLE, M. F. Monographie des Exoascacees D'Europe. Ann de la Soc. Linnéenne de Lyon. *79:* 121-130.

This is a descriptive list, with keys, of species of Exoascus and Taphrina occurring in Europe. Several invalid species are included and nearly one third of the known European species omitted.

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The Genus Taphrina. II: A List of Valid Species

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ABSTRACT: A list, with descriptions, is given of 104 species of the genus Taphrina, which seem likely to prove valid. The recognition of a single genus Taphrina to include forms described under Ascomyces, Exoascus, Taphrina, and Magnusiella, has necessitated the making of a few new combinations of scientific names. Preoccupation of the species name has necessitated the renaming of one species, *Taphrina struthiopteridis* Siemaszko, this becoming *Taphrina siemaszkoi* (Siemaszko) n. comb.

IN compiling the following descriptive list of species of Taphrina, the object has been to render their identification as easy as possible. Descriptions have been reduced to essentials: a brief characterization of the effect on the host, a statement (if the point is on record) as to whether the mycelium grows intercellularly or merely beneath the cuticle, a description of the asci as to position, shape, size, presence or absence of a stalk cell, number, shape and size of spores. Dimensions of asci and spores are given in microns, but the symbol for microns is omitted from the text.

In connection with each species references are given to the paper containing the original description and to other papers in which descriptions may be found. These references are cited by author's name and number, the number referring to the complete citation to be found in the first paper of this series (Mix, *The Genus Taphrina I: An Annotated Bibliography*. University of Kansas Science Bulletin *24*:9: 113-149, 1936). References are also made to Saccardo's *Sylloge Fungorum* by volume, page, and number.

The original idea of Giesenhagen that Exoascus, Magnusiella, and Taphrina should be united to a single genus Taphrina has been accepted. This has necessitated the revision of a few scientific

names. Giesenhagen's objections to Sadebeck's division of the genus into Taphrina, Exoascus, and Magnusiella seem to be well taken, and although Giesenhagen later proposed a genus Magnusiella, this was made with special reference to species which were later found to belong to the genus Taphridium of the Protomycetaceae. Jaczewski places *Taphrina entomospora* Thaxt. in the genus Entomospora of Saccardo. Saccardo did not describe a genus Entomospora, but merely proposed it, and while this aberrant species might well be placed in a separate genus, it may be quite as well to await the discovery of other similar species before so doing.

It has been necessary to assign a new specific name to the form described by Siemaszko on *Matteucia struthiopteris* Tod. since the name *Taphrina struthiopteridis* had been previously used by Nishida. Although occurring on the same host, these two fungi are, from their published descriptions, quite different. For the present, at least, they must be considered as separate species.

Only those species have been excluded or reduced to synonymy which have been so treated by other authors. Some species are probably synonymous. It seems highly probable, for example, that *Taphrina rubrobrunnea* (Pk.) Sacc. is actually *T. caerulescens* (Desm. and Mont.) Tul. Its reduction, however, must await the completion of studies of *T. caerulescens* now in progress in this laboratory. Perhaps certain other species should be regarded with suspicion, but their true status can only be determined after careful morphological study combined with cross-inoculation experiments. Some studies of this nature are being undertaken, but their accomplishment will take time. Meanwhile, it is hoped that the list which follows will eliminate some confusion in the determination of species.

1. *Taphrina cornu-cervi* Giesenhag.

Giesenhagen (77, 108), Sadebeck (80, 93), Jaczewski (170), Saccardo *11*:437, No. 2721.

Host: *Aspidium aristatum* Sw. (*Polystichum aristatum* Presl.) Tumors on fronds.

Asci: Clavate, rounded, 24 x 5-6, narrowing below to 2-4. Stalk cell 4-6 x 2-4.

Spores: Lacking in type specimen.

Distribution: Nepal and Ceylon.

2. *Taphrina fusca* Giesenhag.

Syn.: *Exoascus fuscus* (Giesenhag.) Sacc. and Syd.

Giesenhagen (104, 108), Jaczewski (170), Saccardo *16*:803, No. 2921.

Host: *Aspidium pallidum* Lk. Tumors on fronds.

Mycelium: Subcuticular.

Asci: On upper surface, elongate-clavate, rounded, 20-24 x 5-7; stalk cell long, cylindric.

Spores: Eight in ascus, ellipsoid, 3-4 x 2.

Distribution: Sicily, Albania.

3. *Taphrina moriformis* Bubak.

Bubak (128), Jaczewski (170), Saccardo *16*:766, No. 398.

Host: *Aspidium rigidum* Sw. Outgrowths on fronds.

Asci: Subcylindric, 30-45 x 4-6, narrowed at base.

Spores: Not known.

Distribution: Montenegro.

4. *Taphrina filicina* Rostr.

Syn.: *Ascomyces filicinus* Rostr.; *Exoascus filicinus* (Rostr.) Sacc.

Johanson (56), Sadebeck (80, 93), Giesenhagen (94, 104, 108), Saccardo *8*:819, No. 3354.

Host: *Aspidium spinulosum* (O. F. Mull) Sw. According to Jaczewski (170), also on *Athyrium filix-femina* Roth., and *Nephrodium phegopteris* (*Phegopteris phegopteris* (L.) Underw.?). Spots on fronds.

Mycelium: Subcuticular.

Asci: Amphigenous, clavate, rounded, 29-38 x 5-9, attenuate at base to width 3.5-4.5; no stalk cell.

Spores: Often eight in ascus, oblong or ovoid, 4-5 x 2.

Distribution: Sweden, and (according to Jaczewski) Moscow district and Caucasus, Russia.

5. *Taphrina lutescens* Rostr.

Syn.: *Magnusiella lutescens* (Rostr.) Sadeb.

Rostrup (71), Sadebeck (80, 93), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *10*:68, No. 4729.

Host: *Dryopteris thelypteris* (L.) A. Gray. Yellow spots on fronds.

Mycelium: Intercellular.

Asci: Slender, 60-75 x 8-9; no stalk cell.

Spores: Unknown. Conidia numerous, 4-5 x 0.5-1.

Distribution: Denmark, Germany, Russia.

6. *Taphrina athyrii* Siemaszko

Jaczewski (170).

Host: *Athyrium filix-femina* Roth.

Asci: Hypophyllous, clavate, truncate or rounded, 20-32 x 5-7.

Spores: Usually 6 to 8 in ascus, ellipsoid, 4-5.5 x 3.3-4.5.

Distribution: Caucasus.

7. *Taphrina vestergrenii* Giesenhag.

Syn.: *Exoascus vestergrenii* (Giesenhag.) Sacc. and Syd.

Giesenhagen (108), Jaczewski (170), Saccardo *16*:1152, No. 4789; *18*:196, No. 3849.

Host: *Dryopteris filix-mas* Schott.

Mycelium: Subcuticular.

Asci: Amphigenous, cylindric, rounded or truncate, 25 x 6; stalk cell truncate.

Spores: Eight in ascus, suboblong, 7 x 2.5-3.

Distribution: Baltic Russia, Sweden, Switzerland, Alsace.

8. *Taphrina struthiopteridis* Nishida

Nishida (140).

Host: *Matteucia struthiopteris* Todaro. Yellow spots on fronds.

Asci: Hypophyllous, clavate, rounded or truncate, 16-28 x 4-6; stalk cell 4-7 x 3-4.

Spores: Usually eight in ascus, spherical, diameter 2.

Distribution: Japan.

9. *Taphrina siemaszkoi* (Siemaszko) n. comb.

Syn.: *Taphrina struthiopteridis* Siemaszko.

Siemaszko (155), Jaczewski (170), Saccardo 24:1304.

Host: *Matteucia struthiopteris* Tod. Yellow spots on fronds.

Asci: Hypophyllous, clavate, rounded, 28-40 x 6-7 (170).

Spores: Six to eight in ascus, subglobose, 4-5.5 x 3.3-4.5.

Distribution: Caucasus.

10. *Taphrina fasciculata* (Lagerh. and Sadeb.) Giesenhag.

Syn.: *Magnusiella fasciculata* Lagerh. and Sadeb.

Sadebeck (93), Giesenhagen (94, 108).

Host: *Nephrodium* sp. Spots on fronds.

Asci: Resembling those of *T. potentillae*, 50-70 x 9-12; stalk cell present, narrower than ascus, dimensions not given.

Spores: Ovate, 5-8 x 4.

Distribution: Quito, Ecuador, South America.

11. *Taphrina hiratsukae* Nishida

Nishida (140), Saccardo 22:766, No. 5878.

Host: *Onoclea sensibilis* L., *Nephrodium thelypteris* Desv. (*Dryopteris thelypteris* (L.) A. Gray?).

Asci: Clavate or fusiform, rounded or truncate, 18-30 x 4-6; stalk cell 7-8 x 3-4.

Spores: Usually 8 in ascus, elliptic, 4-5 x 2-3.

Distribution: Japan.

12. *Taphrina osmundae* Nishida

Nishida (140).

Host: *Osmunda regalis* L. var. *japonica* Willd. Spots on fronds.

Asci: Hypophyllous, rarely epiphyllous, oblong or oblong clavate, 32-44 x 17-25; no stalk cell.

Spores: Numerous, minute.

Distribution: Japan.

13. *Taphrina wettsteiniana* Herzf.

Herzfeld (136), Palm 152), Jaczewski (170), Saccardo *24*:1303.

Host: *Polystichum lonchitis* (L.) Roth.
Mycelium: Intercellular.
Asci: Slender-cylindric, rounded or blunt, 50-70 x 5-7; stalk cell present or absent, half length of ascus.
Spores: Eight in ascus, spindle shaped, sometimes slightly constricted in middle, 5 x 12.
Distribution: North Tyrol.

14. *Taphrina tonduziana* P. Henn.

Hennings (113), Jaczewski (170), Saccardo *18*:197, No. 3855.

Host: *Pteris aculeata* Sw. Spots on fronds.
Asci: Hypophyllous, clavate, rounded or truncate, 16-24 x 6-8.
Spores: Eight in ascus, fusiform or clavate, 6-7 x 1.5-2.5.
Distribution: Central America.

15. *Taphrina uleana* (P. Henn.) Giesenhag.

Syn.: *Exoascus uleanus* P. Henn.

Hennings (119), Jaczewski (170), Saccardo *18*:196, No. 3850.

Host: *Pteris decurrens* Presl. Spots on fronds.
Asci: Hypophyllous, cylindric-clavate, truncate, 30-35 x 12-15.
Spores: Eight in ascus, subglobose or ovoid, 6-10 x 6-8.
Distribution: Brazil.

16. *Taphrina laurencia* Giesenhag.

Giesenhagen (77, 94, 108), Sadebeck (80, 93), Jaczewski (170), Saccardo *11*:437, No. 2722.

Host: *Pteris quadriaurita* Retz. Bushy outgrowths on fronds.
Mycelium: Intracellular.
Asci: Formed within epidermal cells, clavate, 24 x 7; stalk cell cylindric 19-6-7.
Spores: Not present in type-specimen. Later reported by Giesenhagen (108) as eight in ascus and in size near those of *T. vestergrenii* (7 x 2.5-3).
Distribution: Ceylon.

17. *Taphrina rhomboidalis* Syd. and Butl.

Sydow and Butler (141), Jaczewski (170), Saccardo *24*:1303, No. 7559.

Host: *Pteris quadriaurita* Retz. Spots on leaves.
Asci: Amphigenous, clavate, broader above, rounded, 30-32 x 6.5-8.
Spores: Ellipsoid, 5-7.5 x 2-3.
Distribution: India.

18. *Taphrina acericola* Massal.

Syn.: *Exoascus acericola* (Massal.) Sacc.

Massalongo (84), Giesenhagen (94, 108), Jaczewski (170), Saccardo *11*:436, No. 2710.

Host: *Acer campestre* L. Spots on leaves.

Asci: Hypophyllous, rarely amphigenous, cylindric-clavate 16-20 x 6-8; stalk cell variable, 10-12 x 4-6.

Spores: Usually eight in ascus, subglobose, diameter 2.5-3.5.

Distribution: Italy.

19. *Taphrina jaczewski* Palm.

Syn.: *Excascus confusus Jacz.*

Jaczewski (111), Palm (152), Jaczewski (170), Saccardo *18*:196, No. 3848, *24*:1301, No. 7551.

Host: *Acer campestre* L. Witches' brooms.

Mycelium: Intercellular.

Asci: Hypophyllous, oblong-cylindric, 16-20 x 8-10; stalk cell roundish or irregular in form.

Spores: Usually 6 in ascus, ovoid, 5-6 x 3-4.

Distribution: Caucasus.

20. *Taphrina aceris* (Dearn. and Barth.) n. comb.

Syn.: *Exoascus aceris* Dearn. and Barth.

Dearness (150), Saccardo *24*:1300, No. 7547.

Host: *Acer grandidentatum* Nutt. Spots on leaves.

Asci: Hypophyllous, short-clavate or cylindric, 30 x 9.

Spores: Subglobose or irregular, 4.5-6 x 3-4.5.

Distribution: Utah, U. S. A.

21. *Taphrina acerina* Eliass.

Syn.: *Exoascus acerinus* (Eliass.) Sacc.

Eliasson (91), Palm (152), Jaczewski (170), Saccardo *14*:823, No. 3075.

Host: *Acer platanoides* L. Deforming whole leaves.

Mycelium: Subcuticular.

Asci: Amphigenous, more often hypophyllous, broad cylindric or clavate, round or truncate, often attenuate at base, 15-23 x 9-12; stalk cell rounded at base, 7-9 x 12-15.

Spores: Eight in ascus, globose, diameter 4-5.

Distribution: Sweden, Russia.

22. *Taphrina pseudoplatani* (Massal.) Jaap.

Syn.: *Taphrina polyspora* (Sor.) Joh. var. *pseudoplatani* Massal.; *Taphrina acericola* Massal. (var.) *pseudoplatani* Massal.

Massalongo (76, 84), Jaap (151), Palm (152), Jaczewski (170), Saccardo *11*:436, No. 2710.

Host: *Acer pseudoplatanus* L. Spots on leaves.

Asci: Hypophyllous, subcylindric or clavate, rounded, 16-24 x 10-12 (76) or 18-26 x 7-10 (84); no stalk cell (76), stalk cell 7 x 15 (84).

Spores: Numerous, globose or ellipsoid, diameter 2-2.5.

Distribution: Italy.

23. *Taphrina nikkoensis* Kusano

Syn.: *Exoascus nikkoensis* (Kus.) Sacc. and Trott.

Kusano (130), Jaczewski (170), Saccardo *22*:763, No. 5867.

Host: *Acer purpurascens* Fr. and Sav. Spots on leaves.

Mycelium: Subcuticular.

Asci: Mostly hypophyllous, cylindric or somewhat clavate, rounded or subtruncate, 40-50 x 10-13; stalk cell 10-15 x 10-13.

Spores: Uusally eight in ascus, globose, diameter 5, ellipsoid, 4-5 x 7.

Distribution: Japan.

24. *Taphrina lethifera* (Peck) Sacc.

Syn.: *Ascomyces letifer* Peck.

Peck (58), Jaczewski (170), Saccardo *10*:67, No. 4723.

Host: *Acer spicatum* Lam. Deforming leaves.

Asci: Hypophyllous, cylindric, obtuse or subtruncate, 0.0016 to 0.0020 in. x 0.0006 to 0.0008 in. (Peck), 40-50 x 15-20 (Saccardo).

Spores: Subglobose or narrow elliptic, 0.00016-0.00020 in. x 0.00008 x 0.00012 in. (Peck), 4-5 x 2-3 (Saccardo).

Distribution: Elizabethtown, New York, U. S. A.

25. *Taphrina polyspora* (Sorok.) Johans.

Syn.: *Ascomyces polysporus* Sorok.; *Exoascus aceris* Linh.

Sorokine (24), Fisch (49), Johanson (52), Sadebeck (80, 93), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *8*:813, No. 3327.

Host: *Acer tataricum* L. Spots on leaves.

Asci: Usually epiphyllous, cylindric, rounded, 33-47 x 12-17; no stalk cell.

Spores: Eight in ascus, globose, diameter 4-5, rarely seen. Asci filled with conidia, diameter 3-4.

Distribution: Western Europe.

26. *Taphrina aesculi* (Patterson) Giesenhag.

Syn.: *Ascomyces deformans* var. *aesculi* Ell. and Ev. *Exoascus aesculi* (Ell. and Ev.) Patterson.

Harkness (68), Patterson (92), Giesenhagen (94, 108), Jaczewski (170), Saccardo *22*:763, No. 5867. Ellis and Everhart, North American Fungi, No. 1887.

Host: *Aesculus californica* Nutt. Young shoots and leaves.

Asci: Amphigenous, cylindric, rounded, 16-18 x 7-9; no stalk cell. Giesenhagen (94) gives dimensions of ascus as 25-30 x 9, and of stalk cell 5-8 x 15.

Spores: Elliptic, 6 x 3.

Distribution: California, U. S. A.

27. *Taphrina media* Palm.

Syn.: *Exoascus medius* (Palm) Jacz.

Palm (152), Jaczewski (170), Saccardo *24*:1301, No. 7552.

Host: *Alnus glutinosa* Medic. Witches' brooms.

Mycelium: Subcuticular.

Asci: Broad cylindric, truncate at apex, 25-90 x 10-12.
Spores: Eight in ascus, globose, diameter 3-5.
Distribution: Sweden.

28. *Taphrina sadebeckii* Johans.

Syn.: *Exoascus alni* de By. in part; *Exoascus flavus* Sadeb.; *Exoascus epiphyllus* Sadeb. var. *maculans*; *Ascomyces tosquinetii* Westend. in part.

Westendorp (12), Tulasne (14), Sadebeck (47, 61, 73, 80, 93), Johanson (52), Giesenhagen (108), Palm (152), Jaczewski (170), Saccardo 8:816, No. 3338.

Host: *Alnus glutinosa* Medic.; *A. tinctoria* Sarg. (*A. hirsuta* Turcz); *A. hybrida* A. Br.; *A. incana* Willd. var. *sibirica* Spach. (*A. hirsuta* Turcz. var. *sibirica* Schneid.). Yellow spots on leaves.

Asci: Hypophyllous, cylindric, truncate, 41-55 x 14-18, with yellow contents; stalk cell 18-22 x 18-22.

Spores: Globose, diameter 6.5.

Distribution: Europe.

29. *Taphrina tosquinetii* (Westend.) Magnus

Syn.: *Ascomyces tosquinetii* Westend.; *Taphrina alnitorqua* Tul.; *Exoascus alnitorquus* Sadeb.; *Exoascus tosquinetii* Magnus; *Exoascus alni* de By. in part.

Westendorp (12), Tulasne (14), Fuckel (15), Sadebeck (47, 73, 80, 93), Magnus (70), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo 8:817.

Host: *Alnus glutinosa, A. hybrida* A. Br. Deforming leaves and twigs.

Asci: Cylindric, truncate, 31-37 x 6-7; stalk cell 11-20 x 6-7, inserted between epidermal cells.

Spores: Usually 8, globose, diameter 3-5.

Distribution: Europe.

30. *Taphrina alni-incanae* (Kühn) Magn.

Syn.: *Taphrina alni-incanae* (Kühn) Sadeb.; *Ascomyces alni* Berk. and Br.; *Exoascus alnitorquus* (Tul.) forma *alni-incanae* Kühn. in Litt.; *Exoascus alnitorquus* (Tul.) Sadeb. in part: *Exoascus alni* de By. in part; *Exoascus alni* de By. var. *strobilinus* Thm.; *Ascomyces tosquinetii strobilina* Rostr.; *Exoascus amentorum* Sadeb.

Berkeley and Broome (25), Rostrup (71), Sadebeck (47, 73, 80, 93), Magnus (70), Patterson (92), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *10*:69, No. 4733.

Host: *Alnus incana* Willd., *A. glutinosa* Medic., *A. hybrida* A. Br., *A. rubra* Bong., *A. rugosa* (Du Roi) Spreng. Deforming female catkins.

Asci: Cylindric, truncate, 40-45 x 10 (Sadebeck), 40-50 x 10 (Giesenhagen), 35-41 x 9-10 (Patterson), inserted for about one-third of length between epidermal cells; no stalk cell.

Spores: Usually 8 in ascus, globose, diameter 5.

Distribution: Europe, North America.

31. *Taphrina epiphylla* Sadeb.

Syn.: *Exoascus epiphyllus* Sadeb.; *Taphrina sadebeckii* Johans. var. *borealis* Johans.; *Taphrina borealis* Johans.

Sadebeck (47, 73, 80, 93), Johanson (52), Rostrup (71), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo 8:816; No. 3339, 3340.

Host: *Alnus incana* Willd. Witches' brooms.

Mycelium: Intercellular.

Asci: On both surfaces of leaf, broad cylindric, truncate, 33-40 x 15-20, inserted in stalk cell. Latter truncate below, 8-9 x 20-33, or pointed, 15-20 x 20-30. (Johanson's variety borealis had asci 37-54 x 15-17, stalk cells 12-25 x 17-24.)

Spores: Eight in ascus, globose, diameter 5-6.

Distribution: Europe.

32. *Taphrina klebahni* Wieben.

Wieben, (176).

Host: *Alnus incana* Willd. Yellowish spots on leaves.

Mycelium: Subcuticular.

Asci: Cylindric, broader and truncate at apex, acute at base and somewhat inserted, 35-45 x 15-20.

Spores: Eight in ascus, globose, diameter 5.

Distribution: Hamburg, Germany.

33. *Taphrina robinsoniana* Giesenhag.

Syn.: *Exoascus robinsonianus* (Giesenhag.) Sacc. and Trott.; *Taphrina alnitorqua* Robins. not Tul.

Giesenhagen (94, 108), Saccardo *22*:765, No. 5873.

Host: *Alnus incana* Willd. Deforming carpels.

Mycelium: Subcuticular.

Asci: Cylindric, subround at apex, truncate at base; 29-37 x 6-10. Stalk cell 15-17 x 6-10.

Spores: Eight in ascus, globose, diameter 3.5-6.

Distribution: North America.

34. *Taphrina japonica* Kusano.

Syn.: *T. alni-japonicae* Nishida.

Kusano (125), Nishida (140), Jaczewski (170), Saccardo *18*:197, No. 3854.

Host: *Alnus japonica* Sieb. and Tsug. Witches' brooms.

Asci: Hypophyllous, cylindric, round or obtuse, sometimes slightly broader at base. 60-90 x 16-25. No stalk cell.

Spores: Numerous, diameter 2-3.

Distribution: Japan.

35. *Taphrina viridis* (Sadeb.) Maire.

Syn.: *Exoascus viridis* Sadeb.: *Taphrina alnastri* Lagerh.

Jaap (110), Maire (137), Saccardo *24*:1300, No. 7548.

Host: *Alnus viridis* DC. Spots on leaves.

Asci: Ellipsoid oblong, rounded, 16-22 x 10; stalk cell inserted between epidermal cells.

Spores: Subglobose or ellipsoid. 5-6 x 3-4.

Distribution: Germany, Italy.

36. *Taphrina willeana* Svends.

Svendsen (115), Juel (133), Palm (152), Jaczewski (170).

Host: *Betula alpestris* Fr. Spots on leaves.

Mycelium: Subcuticular.

Asci: Amphigenous, broad cylindric, truncate or rarely emarginate, 40-50 x 15-20; stalk cell broad, 20-24 x 24-30.

Spores: Numerous, 6-8 x 4-5.

Distribution: Norway, Sweden.

37. *Taphrina betulicola* Nishida

Nishida (140).

Host: *Betula ermanni* Cham. var. *nipponica* Maxim. Witches' brooms.

Asci: Cylindrical, rounded or truncate, 36-42 x 14-22; stalk cell broad, 8-20 x 20-26.

Spores: Numerous, minute.

Distribution: Japan.

38. *Taphrina alpina* Johans.

Syn.: *Exoascus alpinus* (Johans.) Sadeb.

Johanson (56), Sadebeck (80, 93), Giesenhagen (94, 108), Juel (133), Palm (152), Jaczewski (170), Saccardo 8:818:3349.

Host: *Betula nana* L., *B. verrucosa* Ehrh., *B. ermanni* Cham. Witches' brooms.

Mycelium: Subcuticular.

Asci: Hypophyllous (more often epiphyllous according to Jaczewski), broad cylindric, rounded or truncate, often constricted at base, 20-27 x 9-14; stalk cell often somewhat inserted between epidermal cells, 8-14 (rarely 17-18) x 12-20 (mostly 15-17).

Spores: Usually eight in ascus, globose, diameter 3-5.

Distribution: Sweden, Russia, Kamchatka.

39. *Taphrina bacteriosperma* Johans.

Syn.: *Exoascus bacteriospermus* (Johans.) Sadeb.

Johanson (56), Sadebeck (80, 93), Patterson (92), Giesenhagen (94, 108), Juel (133), Palm (152), Jaczewski (170), Saccardo 8:814, No. 3330.

Host: *Betula nana* L., *B. odorata* Bechst., *B. alpestris* Fr., *B. glandulosa* Michx. Deformation of leaves and twigs.

Mycelium: Subcuticular.

Asci: More often epiphyllous, broad cylindric, rounded or rounded-truncate, often dilated, 47-80 x 14-20, at base often 28-30 broad; no stalk cell.

Spores: Globose, diameter 3.6-4.5 (Jaczewski). Conidia numerous, rod-shaped, 6.8-7 x 1.

Distribution: Sweden, Greenland, Russia, North America.

40. *Taphrina nana* Johans.

Syn.: *Exoascus nanus* (Johans.) Sacc.; *Exoascus nanus* (Johans). Sadeb.

Johanson (52), Sadebeck (80, 93), Giesenhagen (94, 108), Juel (133), Palm (152), Jaczewski (170), Saccardo 8:818, No. 3348.

Host: *Betula nana* L., *B. odorata* Bechst., *B. alpestris* Fr. Witches' brooms.

Mycelium: Intercellular.

Asci: Mostly epiphyllous, cylindric, truncate or rounded, 18-24 x 7-9, rarely 24-30 x 7-9; stalk cell 7-10, rarely 12-15 x 8-17, truncate at base.

Spores: Often eight in ascus, globose, diameter 3-5.

Distribution: Swedish Lapland, Kamchatka.

41. *Taphrina carnea* Johans.

Johanson (52), Sadebeck (80, 93), Giesenhagen (94, 108), Juel (133), Patterson (92), Palm (152), Jaczewski (170), Saccardo 8:813, No. 3329.

Host: *Betula gmelini* Bge. (*B. fruticosa* Pall) *B. humilis* Schr., *B. nana* L., *B. intermedia* Thomas, *B. ordorata* Bechst., *B. pubescens* Ehrh., *B. tortuosa* Led. Spots on leaves.

Asci: Mostly epiphyllous, broad cylindric, rounded or truncate, 44-80 x 14-30; no stalk cell.

Spores: Numerous (conidia).

Distribution: Sweden, Russia.

42. *Taphrina lagerheimi* Palm.

Palm (152), Jaczewski (170), Saccardo 24:1302, No. 7553.

Host: *Betula odorata* Bechst. Deformation of leaves and twigs.

Mycelium: Subcuticular.

Asci: Hypophyllous, cylindric, rounded truncate, 53-60 x 13.5-17; stalk cell 19.5-23.5 x 19.5-26.

Spores: Globose, diameter 4.5-6, condidia globose, minute.

Distribution: Sweden.

43. *Taphrina lata* Palm.

Palm (152), Jaczewski (170), Saccardo 24:1302, No. 7555.

Host: *Betula odorata* Bechst. Deforming leaves and twigs.

Mycelium: Subcuticular.

Asci: Hypophyllous, cylindric, rounded, 40-45 x 18-22; stalk cell 16-20 x 25-33.

Spores: Ascospores not seen, conidia numerous, 3-5 long.

Distribution: Sweden.

44. *Taphrina splendens* Palm.

Palm (152), Jaczewski (170), Saccardo 24:1302, No. 7556.

Host: *Betula odorata* Bechst. Witches' brooms.

Mycelium: Subcuticular.

Asci: Hypophyllous, subcylindric, truncate-rounded, slightly constricted toward base, 59-71 x 20-23; stalk cell truncate, 20-25 x 20-24.

Spores: Ascospores not seen, conidia numerous, minute, globose.

Distribution: Lapland, Sweden.

45. *Taphrina lapponica* Juel.

Syn.: *Exoascus lapponicus* (Juel) Jacz.

Juel (142), Palm (152), Jaczewski (170), Saccardo 24:1302, No. 7554.

Host: *Betula odorata* Bechst., *B. alpestris* Fr. Deforming leaves and twigs.
Mycelium: Intercellular.
Asci: Hypophyllous, 40 x 16; stalk cell present (as in *T. alpina* according to Jaczewski).
Spores: Numerous, globose, diameter 3.5, or ellipsoid, 4 x 2.5 (Jaczewski).
Distribution: Sweden.

46. *Taphrina betulina* Rostr.

Syn.: *Exoascus betulinus* (Rostr.) Sadeb.; *Exoascus turgidus* Sadeb. in part.

Rostrup (43, 71), Johanson (52), Sadebeck (80, 93), Giesenhagen (94, 108), Juel (133), Palm (152), Jaczewski (170), Saccardo 8:818.

Host: *Betula odorata* Bechst., *B. carpatica* Waldst., *B. pubescens* Ehrh., *B. tortuosa* Led. Witches' brooms.
Mycelium: Subcuticular.
Asci: Hypophyllous, cylindric, rounded, 45-55 x 15-20 (sometimes only 30-40 long); stalk cell variable, 20-25 x 15-20, or broadened below, 10 x 20-25, not inserted.
Spores: Globose, diameter 5.
Distribution: Europe.

47. *Taphrina betulae* (Fkl.) Johans.

Syn.: *Exoascus betulae* Fk.; *Ascomyces betulae* Magn.

Fuckel (17), Sadebeck (47, 80, 93), Johanson (52), Rostrup (71), Giesenhagen (94, 108), Juel (133), Palm (152), Jaczewski (170), Rabenhorst, Fungi Europaei 2734, Saccardo 8:818, No. 3346.

Host: *Betula odorata* Bechst., *B. pubescens* Ehrh., *B. verrucosa* Ehrh. Spots on leaves.
Asci: On both surfaces, broad cylindric, truncate and wider at base. 25-40 x 8-12. Basal cell broad, 8-12 x 12-25.
Spores: Eight in ascus, subglobose, 3-5.
Distribution: Europe.

48. *Taphrina auctumnalis* Palm.

Syn.: *Taphrina betulae* (Fkl.) Johans. var. *auctumnalis* Sadeb.

Sadebeck (47), Juel (133), Palm (152), Jaczewski (170).

Host: *Betula odorata* Bechst., *B. pubescens* Ehrh., *B. verrucosa* Ehrh. Reddish spots on leaves.
Asci: Amphigenous, 15-27 x 6-9; stalk cell often broad, but not beyond 2-5 (Jacz.).
Spores: Globose, diameter 3-5.
Distribution: Europe.

49. *Taphrina janus* (Thomas) Giesenhag.

Syn.: *Exoascus janus* Thomas.

Thomas (99), Giesenhagen (108), Juel (133), Palm (152), Jaczewski (170), Saccardo *14*:824, No. 3076.

Host: *Betula odorata* Bechst., *B. verrucosa* Ehrh. Spots on leaves.

Asci: Amphigenous, 52-63 x 9-15.

Spores: Globose, diameter 3-5.

Distribution: Switzerland, Sweden.

50. *Taphrina flava* Farl.

Syn.: *Magnusiella flava* (Farl.) Sadeb.

Farlow (44), Sadebeck (93), Giesenhagen (94, 108), Jaczewski (170), Saccardo *8*:813, No. 3328.

Host: *Betula populifolia* Marsh., *B. alba* L. var. *papyrifera* (Marsh.) Spach. Yellow spots on leaves.

Mycelium: Intercellular.

Asci: Cylindric, obtuse or truncate at both extremities, 38-57 x 20-23, no stalk cell.

Spores: Oblong, tenuous, 3-7 x 1.5-2.

Distribution: North America.

51. *Taphrina turgida* (Sadeb.) Giesenhag.

Syn.: *Exoascus turgidus* Sadeb.

Sadebeck (47, 80, 93), Giesenhagen (94, 108), Juel (133), Palm (152), Jaczewski (170), Saccardo *8*:818, No. 3347.

Host: *Betula verrucosa* Ehrh. Witches' brooms.

Mycelium: Subcuticular.

Asci: Hypophyllous, cylindric, truncate, 46-50 x 15; stalk cell tapering, inserted between epidermal cells, 17-30 x 15.

Spores: Globose, diameter 3-4.

Distribution: Europe.

52. *Taphrina carpini* (Rostr.) Johans.

Syn.: *Exoascus carpini* Rostr.

Rostrup (35, 71), Sadebeck (47, 73, 80, 93), Johanson (52, 56), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *8*:814, No. 3331.

Host: *Carpinus betulus* L., *C. orientalis* Mill. Witches' brooms.

Mycelium: Subcuticular.

Asci: Hypophyllous, cylindric, rounded, broad and truncate at base, 25 x 8-12, 20-24 broad at base; no stalk cell.

Spores: Globose, diameter 4.

Distribution: Northern and central Europe.

53. *Taphrina australis* (Atk.) Giesenhag.

Syn.: *Exoascus australis* Atk.

Atkinson (86), Giesenhagen (94, 108), Jaczewski (170), Saccardo *11*:437, No. 2719.

Host: *Carpinus caroliniana* Walt. Spots on leaves.

Mycelium: Subcuticular.

Asci: On upper surface, cylindric truncate, base narrowed to short foot, 30-60 x 7-10; no stalk cell.

Spores: Globose, diameter 4-6.

Distribution: Alabama, U. S. A.

54. *Taphrina castanopsidis* (Ell. and Ev.) Jenkins.

Jenkins (188).

Host: *Castanopsis chrysophylla* A. DC. Spots on leaves.

Asci: Hypophyllous, cylindric, rounded, 80-165 x 13-17, inserted basal portion variable in form and size.

Spores: Eight in ascus, diameter up to 10, conidia 3-5 x 1.5-2.5.

Distribution: California, U. S. A.

55. *Taphrina celtis* Sadeb.

Syn.: *Exoascus celtidis* (Sadeb.) Sacc.; *Exoascus aemiliae* Passer.

Sadebeck (73, 80, 93), Passerini (67), Giesenhagen (94, 108), Jaczewski (170), Saccardo *10*:69, No. 4731, 4732.

Host: *Celtis australis* L. Spots on leaves.

Asci: Hypophyllous, cylindric, blunt-rounded, 25-28 x 8-10; stalk cell flattened, 8-10 x 25-30.

Spores: Globose, diameter 3-5.5.

(Passerini's *Exoascus aemiliae*, declared by Sadebeck to be identical with *T. celtis*, had asci 12-15 x 6-7; stalk cell not found, spores globose, diameter 2.5-3.)

Distribution: Central Europe.

56. *Taphrina coryli* Nishida

Nishida (140), Martin (167), Jaczewski (170).

Host: *Corylus americana* Walt., *C. heterophylla* Fisch., *C. rostrata* Ait. var. *sieboldiana Maxim.* Yellow spots on leaves, and leaf-curl.

Asci: Usually hypophyllous, cylindric or cylindric clavate, rounded, 20-24 x 8-12; stalk cell roundish flattened, 8-12 x 8-16.

Spores: Usually eight in ascus, globose, diameter 4-6.

Distribution: Japan, North America.

57. *Taphrina crataegi* Sadeb.

Syn.: *Exoascus crataegi* (Sadeb.) Sacc.; *Exoascus bullatus* Sadeb. in part.

Sadebeck (47, 73, 80, 93), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *10*:70, No. 4735.

Host: *Crataegus oxyacantha* L., *C. monogyna* Jacq., *C. sanguinea* Pall. Deforming leaves and rarely flowers. Witches' brooms recorded by Sadebeck and Palm.

Mycelium: Subcuticular.

Asci: Hypophyllous, cylindric, truncate, 25-35 x 8; stalk cell 6-8 x 6-8.

Spores: Eight in ascus, globose, diameter 4.5.

Distribution: Europe, comparatively rare.

58. *Taphrina maculans* Butl.

Butler (139), Sydow and Butler (141), Jaczewski (170), Saccardo *24*:1303, No. 7560.

Host: *Curcuma longa* L., *C. angustifolia* Roxb., *C. amadae, Zingiber casumunar* Roxb., *Z. zerumbet* Rosc. Yellow-brown spots on leaves.

Mycelium: Growing in walls of cells, possessing haustoria.

Asci: Clavate, rounded or truncate, often attenuate at base, 20-30 x 6; provided with a stalk cell or even a row of two or three.

Spores: Five to ten, mostly eight, in ascus, ovoid or sub-elongate, 4-6.5 x 2-2.5.

Distribution: India.

59. *Taphrina linearis* Sydow.

Sydow and Sydow (146), Saccardo *24*:1303, No. 7561.

Host: *Globba marantina* L. Spots on leaves.

Asci: Clavate, rounded or truncate, 25 x 7-9 (immature); with one or a few stalk cells.

Spores: Not known.

Distribution: Philippine Islands.

60. *Taphrina entomospora* Thaxt.

Syn.: *Exoascus entomosporus* (Thaxt.) Sacc. and Trott.; *Entomospora antarctica* (Sacc.) Jacz.

Thaxter (138), Jaczewski (170), Saccardo *22*:765, No. 5874.

Host: *Nothofagus antarctica* Oerst. Spots on leaves.

Asci: Subcylindric, rounded or subtruncate, 55-60 x 13-15; stalk cell broader than ascus.

Spores: Eight in ascus, appendiculate, 9-10 x 3-4. Appendages of two orders, terminal 8-12 x 3-5, subterminal 15-25 x 0.8.

Distribution: Punta Arenas, Patagonia, South America.

61. *Taphrina ostryae* Massal.

Syn.: *Exoascus ostryae* Massal.

Massalongo (60), Sadebeck (73, 80, 93), Giesenhagen (94, 108), Jaczewski (170), Saccardo *8*:818, No. 3350.

Host: *Ostrya carpinifolia Scop.* Spots on leaves.

Asci: Hypophyllous, oblong, obtuse, 20-24 x 12-14; stalk cell variable in form and size, inserted.

Spores: Eight in ascus, globose, diameter 5-7.

Distribution: Italy, Caucasus.

62. *Taphrina virginica* Seym. and Sadeb.

Patterson (92), Sadebeck (93), Giesenhagen (94, 108), Jaczewski (170), Saccardo *18*:824, No. 3078.

Host: *Ostrya virginica* Willd. Spots on leaves.

Asci: Hypophyllous, cylindric, rounded or truncate with truncate base, 25 x 10; no stalk cell.

Spores: Numerous, minute.

Distribution: North America.

63. *Taphrina kusanoi* Ikeno

Ikeno (118), Jaczewski (170), Saccardo *22*:765, No. 5875.

Host: *Pasania cuspidata* Oerst. Swellings on leaves.

Asci: Hypophyllous, cylindric, rounded, 102-117 x 13-19; no stalk cell.

Spores: Numerous (conidia), small, ellipsoid.

Distribution: Japan.

64. *Taphrina rhizophora* Johans.

Syn.: *Taphrina aurea* auct. in part.; *Exoascus aureus* auct. in part; *Exoascus rhizophorus* (Johans.) Sadeb.

Johanson (56), Sadebeck (73, 80, 93), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *8*:812, No. 3326.

Host: *Populus alba* L., and *P. tremula* L., *P. bachofeni* (*P. tremula* x *alba*).

Mycelium: Subcuticular.

Asci: With yellow contents, elongate, clavate, rounded, attenuate at base to root-like appendage, often forked, inserted between epidermal cells, 120-160 x 20-22, inserted part narrowing to diameter 6; no stalk cell.

Spores: Globose, diameter 4.

Distribution: Europe, North America.

65. *Taphrina aurea* Fr.

Syn.: *Taphrina populina* Fr.; *Ascomyces aureus* (Pers.) Magn.; *Exoacus aureus* (Fr.) Sadeb.; *Exoascus populi* Thm.; *Exoascus flavo-aureus* Cocc.

Fries (1, 2, 3, 4, 7), Sadebeck (47, 73, 80, 93), Johanson (52, 56), Cocconi (88), Patterson (92), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *8*:812, No. 3325.

Host: *Populus nigra* L. and *Populus* spp. Yellow spots on leaves.

Asci: With yellow contents. Form variable, cylindric or clavate, rounded or truncate, narrowed toward base, size as reported by various authors 47-112 x 15-27; stalk cell present or absent, variable in size and form, 4-27 x 8-17.

Spores: Globose, diameter 4, forming numerous conidia.

Distribution: Europe, North America.

66. *Taphrina johansonii* Sadeb.

Syn.: *Taphrina rhizophora* Johans. in part.; *Exoascus johansoni* Sadeb.; *Exoascus aureus* Sadeb. in part.

Sadebeck (73, 80, 93), Rostrup (71), Patterson (92), Giesenhagen (94, 108), Jaczewski (170), Saccardo *10*:68, No. 4725.

Host: *Populus tremula* L., *P. tremuloides* Michx., *P. grandidentata* Michx., *P. fremontii* Wats. Deforming carpels.

Mycelium: Subcuticular.

Asci: With yellow contents, clavate, rounded, deeply inserted, 46-105 x 14-20 (exserted part) or 8 (inserted part) according to Patterson; 92-105 x 16-25 according to Sadebeck; no stalk cell.

Spores: Globose, diameter 4.

Distribution: Europe, North America.

67. *Taphrina potentillae* (Farl.) Johans.

Syn.: *Exoascus potentillae* (Farl.) Sacc.; *Ascomyces potentillae* Farl.; *Exoascus deformans* (Berk.) Fkl. var. *potentillae* Farl.; *Taphrina tormentillae* Rostr.; *Magnusiella potentillae* (Farl.) Sadeb.

Farlow (44), Rostrup (50), Johanson (52), Sadebeck (73, 80, 93), Patterson (92), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo 8:819, No. 3352.

Host: *Potentilla silvestris* Neck., *P. geoides* L., *P. canadensis* L., *P. silvestris* x *procumbens*. Deforming leaves and stems.

Mycelium: Intercellular, hymenium subepidermal.

Asci: Clavate, rounded or truncate, prolonged to pedicel below, 40-55 x 8-10.

Spores: Ovate-oblong, 4 x 5.8.

Distribution: Europe, North America.

68. *Taphrina pruni-acidae* (Jacz.)

Syn.: *Exoascus pruni-acidae* Jacz.; *Taphrina* sp. Laubert.

Laubert (143), Jaczewski (170).

Host: *Prunus acida* (Dum.) Koch. Deforming fruits, flowers, and flower buds.

Asci: 30-36 x 9-10; stalk cell pedicellate, sometimes forked, 6-16 x 3-10.

Spores: 6-9 x 5.

Distribution: Germany.

69. *Taphrina communis* (Sadeb.) Giesenhag.

Syn.: *Exoascus communis* Sadeb.

Sadebeck (80, 93), Patterson (92), Giesenhagen (94, 108), Jaczewski (170), Saccardo *11*:436, No. 2709.

Host: *Prunus americana* Marsh., *P. pumila* Wang., *P. maritima* Wang., and *P. subcordata Benth.* Deforming fruits.

Asci: Clavate, rounded or blunt, 30-40 x 8; stalk cell 15-20 x 3-5. Dimensions of asci given by Giesenhagen as 25-45 x 6-10; stalk cell 15-25 x 3-6.

Spores: Eight in ascus, globose or broad ellipsoid, 5 x 3-4.

Distribution: North America.

70. *Taphrina decipiens* (Atk.) Giesenhag.

Syn.: *Exoascus decipiens* Atk.

Atkinson (86), Giesenhagen (94, 108), Sadebeck (93), Jaczewski (170), Saccardo *11*:436, No. 2714.

Host: *Prunus americana* Marsh. Leaf-curl.

Asci: Hypophyllous, 20-40 x 7-10; stalk cell 6-13 x 7-12.

Spores: Oval or broad-elliptic, diameter 3-4.

Distribution: New York, U. S. A.

70a. Var. *superficialis* Atk.

Deforming your fruits of *P. americana*. Asci 25-30 x 8-11; stalk cell often short.

71. *Taphrina longipes* (Atk.) Giesenhag.

Syn.: *Exoascus longipes* Atk.

Atkinson (86), Giesenhagen (94, 108), Sadebeck (93), Jaczewski (170), Saccardo *11*:436, No. 2713.

Host: *Prunus americana* Marsh. Deforming fruits.

Mycelium: Intercellular.

Asci: 30-40 x 7-10; stalk cell 25-35 x 3-5, inserted between epidermal cells.

Spores: Not described by Atkinson. Given by Jaczewski as globose or ellipsoid, diameter 3-4.

Distribution: New York, U. S. A.

72. *Taphrina mirabilis* (Atk.) Giesenhag.

Syn.: *Exoascus mirabilis* Atk.

Atkinson (86), Giesenhagen (94, 108), Sadebeck (93), Jaczewski (170), Saccardo *11*:436: 2715.

Host: *Prunus angustifolia* Marsh., *P. hortulana* Bailey, *P. americana* Marsh. Deforming shoots.

Asci: Subclavate, rounded or truncate, 25-45 x 8-10; stalk cells rounded below, not inserted, 10-18 x 5-8.

Spores: Elliptic.

Distribution: North America.

72a. Var. *tortilis* Atk.

Deforming fruits of *P. angustifolia*, affecting only one side of fruit. Asci and stalk cells usually a little longer than in species.

73. *Taphrina cerasi* (Fkl.) Sadeb.

Syn.: *Exoascus deformans* f. *cerasi* Fkl.; *Exoascus wiesneri* Rathay.; *Exoascus cerasi* (Fkl.) Sadeb.; *Taphrina gilgii* Henn. and Lindau.; *Exoascus* and *Taphrina deformans* Auct. in part.

Fuckel (15), Rathay (31), Rostrup (71), Sadebeck (73, 80, 93), Hennings (82), Patterson (92), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *10*:69, No. 4734; *11*:436, No. 2711.

Host: *Prunus avium* L., *P. cerasus* L., *P. fruticosa* Pall. Witches' brooms. Also, according to Nishida (140) on *P. pseudocerasus* Lindl. var. *sieboldi* Maxim., and var. *spontanea* Maxim., and on *P. miqueliana* Maxim.

Asci: Slender, clavate, rounded, 35-50 x 5-12; stalk cell 6-16 x 5-9.

Spores: Ellipsoid 6-9 x 5-7.

Distribution: Europe, North America, Japan.

74. *Taphrina reichei* Werd.

Werdermann (158).

Host: *Prunus capollin* Koehne. Leaf-curl.
Asci: Cylindric, obtuse, 26-34 x 8-12; stalk cell 15-18 x 8-10.
Spores: Eight in ascus, subellipsoid, diameter 4-5.5.
Distribution: Mexico.

75. *Taphrina amygdali* (Jacz.) n. comb.

Syn.: *Exoascus amygdali* Jacz.; *Exoascus deformans* (Berk.) Fkl. in part. Jaczewski (170).

Host: *Prunus communis* (L.) Fritsch var. *dulcis*, var. *amara*.
Mycelium: Intercellular.
Asci: Hypophyllous, clavate, rounded, 24x9-11; stalk cell 11x8.3.
Spores: Usually four to eight in ascus, globose, diameter 3-4.
Distribution: Southern Europe.
According to Jaczewski this fungus is distinct from the variety of *T. deformans* described by Campbell (165) from the same hosts.

76. *Taphrina pruni* Tul.

Syn.: *Exoascus pruni* Fkl.

Tulasne (14), Fuckel (15), Sadebeck (47, 73, 80, 93), Giesenhagen (94, 108), Patterson (92), Palm (152), Jaczewski (170), Saccardo 8:817, No. 3342.

Host: *Prunus domestica* L., *P. padus* L., *P. spinosa* L. Deforming fruits. Also, according to Nishida (140) on *P. tomentosa* Thunb., and *P. incisa* Thunb.
Mycelium: Intercellular.
Asci: Cylindric-clavate, rounded, 30-60 x 8-15; stalk cell 10-20 x 8, not inserted.
Spores: Eight in ascus, rarely more. Subglobose, diameter 4-5.
Distribution: Europe, North America, Japan.
Jaczewski would confine the species to the form on *Prunus domestica* and makes the following varieties:
76a. Var. *divaricata* Jacz. On *Prunus divaricata* Led. Russia.
76b. Var. *padi* Jacz. On fruit and twigs of *Prunus padus* L. Asci elongate-cylindric, rounded, 30-35 x 11; stalk cell 19x8. Spores globose, diameter 4. Everywhere that host grows.
76c. Var. *ussuriensis* Jacz. On *Prunus ussuriensis*. Asci cylindric, 41.5 x 11; stalk cell 19.4-24.9 x 5.5-8.3. Spores globose, diameter 5-6. Russia.

77. *Taphrina minor* Sadeb.

Syn.: *Exoascus minor* (Sadeb.) Sacc.

Sadebeck (73, 80, 93), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo *10*:70, No. 4736.

Host: *Prunus fruticosa* Pall. (*P. chamaecerasus* Jacq.). Deforming leaves, buds, and branches. Also, according to Cunningham (161), and Palm (152), on *P. cerasus* L. and, according to Jaczewski (170), on *P. avium* L., *P. cerasus* L., and *P. microcarpa* C. A. Mey.
Mycelium: Subcuticular.

Asci: Terete-clavate, 30-35 x 6-8. Basal cell broader toward base, 8-10 diam. Giesenhagen gives dimensions of asci as 18-35 x 6-8, of stalk cells as 8-10 x 6-10.

Spores: Eight in ascus, 6-7 x 5.

Distribution: Germany, Russia, New Zealand (Siberia).

78. *Taphrina truncicola* Kusano.

Kusano (124), Jaczewski (170), Saccardo *18*:197, No. 3851.

Host: *Prunus incisa* Thunb. Deforming shoots and inflorescences. Also, according to Nishida (140) on *P. maximowiczi* Rupr.

Asci: Cylindric, rounded, 37-45 x 8.7-10; stalk cell cylindric, 13-20 x 10-13.

Spores: Globose, diameter 4-5.8.

Distribution: Japan.

79. *Taphrina insititiae* (Sadeb.) Johans.

Syn.: *Exoascus insititiae* Sadeb.

Sadebeck (47, 73, 80, 93), Johanson (52), Rostrup (71), Giesenhagen (94, 180), Palm (152), Jaczewski (170), Saccardo *8*:817, No. 3344.

Host: *Prunus insititia* L., and *P. domestica* L. Witches' brooms. In North America on *P. pennsylvanica* L. (Giesenhagen, Jaczewski).

Asci: Cylindric-clavate, rounded, 25-30 x 8-10; stalk cell subcubical, subacute at base, inserted, 6-8 x 7-10.

Spores: Globose, diameter 3.5.

Distribution: Northern and Central Europe, North America.

80. *Taphrina cerasi-microcarpae* (Kuschke) Laubert.

Syn.: *Exoascus cerasi-microcarpae* Kuschke.

Kuschke (144), Jaczewski (170), Saccardo *24*:1301, No. 7550.

Host: *Prunus microcarpa* C. A. Mey. (*Cerasus microcarpa* Boiss.). Deforming fruits.

Mycelium: Intercellular.

Asci: Clavate, short stalked, 35-50 x 10-13.

Spores: Globose, oval, or ovate, 5-7.5 x 5-6.25.

Distribution: Transcaucasus.

81. *Taphrina mexicana* Syd.

Sydow and Sydow (156), Jaczewski (170), Saccardo *24*:1302, No. 1557.

Host: *Prunus microphylla* Hemsl. Small witches' brooms, about 5 cm. in diameter.

Asci: Cylindric, round or more often truncate, 28-35 x 6-9; stalk cell 9-13 x 7-10.

Spores: Eight in ascus, ellipsoidal, 3.5-4 x 2.5-3.5.

Distribution: Mexico.

82. *Taphrina mume* Nishida

Yoshino (127), Nishida (140), Saccardo *22*:765, No. 5877.

Host: *Prunus mume* S. and Z., *P. armeniaca* L. *var. ansu* Maxim. Deforming shoots.

Asci: Cylindric, rounded, 25-52 x 8-15; stalk cell 8-12 x 5-15.

Spores: Usually eight in ascus, globose, diameter 4-6.

Distribution: Japan.

83. *Taphrina deformans* (Berk.) Tul.

Syn.: *Exodscus deformans* (Berk.) Fkl.; *Ascomyces deformans* Berk.; *Ascosporium deformans* Berk.

Berkeley (10), Tulasne (14), Fuckel (15), Rathay (28), Sadebeck (47, 73, 80, 93), Rostrup (71), Giesenhagen (94, 108), Patterson (92), Campbell (165), Jaczewski (170), Saccardo *8*:816, No. 3341.

Host: *Prunus persica* L., *P. communis* (L.) Fritsch, deforming leaves, twigs, and rarely flowers.

Mycelium: Intercellular.

Asci: Described by most authors as epiphyllous, but occasionally also hypophyllous (Mix 186), according to Jaczewski exclusively hypophyllous (!). Cylindric, rounded, 25-50 x 8-12; stalk cell 6-8 x 6-10.

Spores: Usually 8, sometimes 4 in ascus, globose, diameter 3-5.

Distribution: World wide.

The form on almond, noted by Rathay and by subsequent authors is described by Campbell (165) as a variety, without naming it as such. Asci are 34 x 11-12, without stalk cells; spores 7 x 5.

84. *Taphrina pseudocerasi* (Shirai) Sacc.

Syn.: *Taphria pseudocerasi* Shirai

Shirai (96), Jaczewski (170), Saccardo *14*:824, No. 3077.

Host: *Prunus pseudocerasus* Lindl., and *P. miquelliana* Maxim. (*P. subhirtella* Miq.). Witches' brooms.

Asci: Terete-clavate, rounded, 40-44 x 6-9; stalk cell 6-9 long.

Spores: Many in ascus, subglobose, 4.5-5 x 3.5-4.5.

Distribution: Japan.

85. *Taphrina andina* Palm.

Syn.: *Exoascus andinus* (Palm.) Sacc. and Trott.

Palm (134), Jaczewski (170), Saccardo *22*:764, No. 5871.

Host: *Prunus salicifolia* HBK. Spots on leaves.

Asci: Epiphyllousor hypophyllous, cylindric, rounded or truncate, 27-31 x 9.5-13.6; stalk cell cuboidal, 9.5-13.6 x 9.5-10.2.

Spores: Eight in ascus, subglobose, 4.5 x 3.5.

Distribution: Quito and Ambato, Ecuador.

86. *Taphrina farlowi* Sadeb.

Syn.: *Exoascus farlowii* (Sadeb.) Sacc.

Sadebeck (73, 80, 93), Giesenhagen (94, 108), Patterson (92), Jaczewski (170), Saccardo *10*:70, No. 4737.

Host: *Prunus serotina* Ehrh., deforming fruits.

Mycelium: Intercellular.

Asci: Scattered, terete-clavate, rounded 20-30 x 8-9; stalk cell elongate, 15-25 x 8-9, not inserted.

Spores: Globose, diameter 4.

Distribution: North America.

87. *Taphrina varia* (Atk.) n. comb.

Syn.: *Exoascus varius* Atk.

Atkinson (86), Giesenhagen (94), Sadebeck (93), Jaczewski (170), Saccardo *11*:436, No. 2717.

Host: *Prunus serotina* Ehrh. Deforming shoots.

Asci: 20-27 x 8-10, stalk cell 12-17 x 8-10.

Spores: Not described.

Distribution: Alabama, U. S. A. Perhaps also on *P. demissa* Walp. in Colorado (Atkinson).

Giesenhagen makes this species synonymous with *T. farlowi*, which, however, occurs on fruits. They should be considered distinct species until further proof of their identity is forthcoming.

88. *Taphrina rostrupiana* (Sadeb.) Giesenhag.

Syn.: *Exoascus rostrupianus* Sadeb.

Sadebeck (80, 93), Giesenhagen (94, 108), Jaczewski (170), Saccardo *11*:435, No. 2708.

Host: *Prunus spinosa* L., deforming fruits.

Asci: Cylindric-clavate, rounded, 35-50 x 7-8; stalk cell variable, 10-16 x 2-6 or 1.5, often pointed below but not inserted.

Spores: Eight in ascus, ellipsoid, 6-7 x 3-4.

Distribution: Europe.

89. *Taphrina pruni-subcordatae* (Zeller) n. comb.

Zeller (177).

Host: *Prunus subcordata* Benth. Deforming fruits.

Asci: Clavate, often truncate, sometimes narrowed above, 54-61 x 10-13; stalk cells not inserted, 12-16 x 5-11.

Spores: Ellipsoid to ovate, 6-10 x 3.5-5.

Distribution: Oregon, California, U. S. A.

90. *Taphrina rhizipes* (Atk.) Giesenhag.

Syn.: *Exoascus rhizipes* Atk.

Atkinson (86), Sadebeck (93), Giesenhagen (94, 108), Jaczewski (170), Saccardo *11*:436, No. 2716.

Host: *Prunus triflora* Roxb., deforming shoots and fruits.

Asci: Clavate, 30-40 x 8-10; stalk cell 25-40 x 3-5. Rhizoidal outgrowths from asci and basal cells penetrate between epidermal cells.

Spores: Not described.

Distribution: Alabama, U. S. A.

91. *Taphrina cecidomophila* (Atk.) Giesenhag.

Syn.: *Exoascus cecidomophilus* Atk.

Atkinson (86), Sadebeck (93), Jaczewski (170), Saccardo *11*:436, No. 2718.

Host: *Prunus virginiana* L., occurring on insect galls on fruits.
Mycelium: Intercellular, but superficial.
Asci: Cylindric or rarely clavate. 30-40 x 6-10; stalk cell broad, rounded below, 6-10 x 10-15.
Spores: Not described.
Distribution: New York, U. S. A.

92. *Taphrina confusa* (Atk.) Giesenhag.

Syn.: *Exoascus confusus* Atk.

Atkinson (86), Giesenhagen (94, 108), Sadebeck (93), Jaczewski (170), Saccardo *11*:436, No. 2712.

Host: *Prunus virginiana* L. Deforming fruits and floral envelopes.
Asci: 30-45 x 8-12; stalk cell 15-30 x 6-10.
Spores: Not described.
Distribution: North America.

93. *Taphrina unilateralis* (Pk.) n. comb.

Syn.: *Exoascus unilateralis* Pk.

Peck (102), Jaczewski (170), Saccardo *16*:803, No. 2920.

Host: *Prunus virginiana* L. Leaf curl.
Asci: Subcylindric, slightly contracted above basal cell, 40-52 x 13-16; stalk cell 13-16 broad and about as long.
Spores: Eight in ascus, globose or broad elliptic, 6-6.5 x 5-8.
Distribution: New York, U. S. A.

94. *Taphrina bullata* (Berk. and Br.) Tul.

Syn.: *Taphrina bullata* (Berk. and Br.) Sadeb.; *Exoascus bullatus* (Berk. and Br.) Fkl.; *Oidium bullatum* Berk. and Br.; *Ascomyces bullatus* Berk.; *Ascosporium bullatum* Berk.

Berkley (8), Tulasne (14), Sadebeck (73, 80, 93), Johanson (52), Rostrup (71), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo 8:817, No. 3343.

Host: *Pyrus communis* L., leaf curl. Also on *Chaenomeles lagenaria* Koidz. (Rostrup).
Mycelium: Subcuticular.
Asci: Cylindric, truncate, 36-40 x 8-9; stalk cell 10-15 x 8-9.
Spores: Globose, diameter 5.
Distribution: Europe.

95. *Taphrina piri* Kusano.

Syn.: *Exoascus piri* (Kusano) Sacc. and Trott.

Kusano (124), Jaczewski (170), Saccardo *18*:197, No. 3852 and *22*:764, No. 5870.

Host: *Pyrus miyabe* Sarg. Spots on leaves.

Asci: Plump-cylindric, rounded-truncate, 29-42 x 9-13; no stalk cell.

Spores: Globose, diameter 3-5.

Distribution: Japan.

96. *Taphrina caerulescens* (Desm. and Mont.) Tul.

Syn.: *Exoascus coerulescens* Sadeb.; *Ascomyces caerulescens* Desm. and Mont.; *Ascomyces quercus* Cke.; *Ascomyces alutaceus* Thm.; *Ascomyces extensus* Pk.; *Taphrina extensa* (Pk.) Sacc.; *Taphrina alutacea* (Thum) Sacc.; *Taphrina quercus* (Cooke) Sacc.

Desmazières (6), Tulasne (14), Cooke (26), Thümen (33), Saccardo (42), Sadebeck (47, 73, 80, 93), Peck (51), Johanson (56), Patterson (92), Giesenhagen (94, 108), Palm (152), Jaczewski (170), Saccardo 8:814, No. 3332, 3333, 815, No. 3334.

Host: *Quercus* spp. Spots on leaves.

Asci: Often amphigenous, broad-cylindric, rounded or truncate, abruptly attenuate at base, with rhizoidal appendage, 55-70 x 15-20; no stalk cell.

Spores: Numerous (conidia) 2.5-3 x 1.5-2.

Distribution: Europe, N. America.

97. *Taphrina rubrobrunnea* (Pk.) Sacc.

Syn.: *Ascomyces rubrobrunneus* Pk.

Peck (58), Jaczewski (170), Saccardo *10*:67, No. 4724.

Host: *Quercus rubra* L. Spots on leaves.

Asci: Oblong, truncate, 50-75 x 15-22.

Spores: Numerous (conidia) subelliptic, 3-4 x 1.5-2.

Distribution: Sandlake, New York, U. S. A.

98. *Taphrina kruchii* (Vuill.) Sacc.

Syn.: *Exoascus kruchii* Vuill.

Kruch (69), Vuillemin (75), Sadebeck (80, 93), Giesenhagen (94, 108), Jaczewski (170), Saccardo *10*:68, No. 4727.

Host: *Quercus ilex* L. Witches' brooms.

Mycelium: Subcuticular.

Asci: Subclavate, 72-80 x 21-23; no stalk cell. Sadebeck and Giesenhagen give dimensions of asci as 65-75 x 15-20, broadening below to a width of 30-40.

Spores: Eight in ascus, globose, diameter 4, conidia 2.5 x 2.

Distribution: France and Italy.

99. *Taphrina randiae* Rehm.

Rehm (112), Jaczewski (170), Saccardo *16*:1152, No. 4790.

Host: *Randia* sp. Spots on leaves.

Asci: Sessile, between epidermal cells, oblong, truncate, narrowed at base, 50 x 25; no stalk cell.

Spores: Globose, diameter 3-4.

Distribution: Serra Orgaos, Brazil.

100. *Taphrina purpurascens* Robins.

Syn.: *Exoascus purpurascens* (Robins.) Sacc.; *Ascomyces deformans* (Berk.) var. *purpurascens* Ell. and Ev.

Robinson (55), Sadebeck (80, 93), Giesenhagen (94, 108), Patterson (92), Jaczewski (170). Ellis and Everhart, North American Fungi No. 1886, Saccardo 8:819, No. 3353.

Host: *Rhus copallina* L. leaves.

Asci: Dumbbell-shaped, constricted in the middle. 24-32 x 9-14, 6-11 broad in constricted part, 9-21 at base; no stalk cell.

Spores: Ellipsoidal, 3.5-5 x 2.5-4.

Distribution: North America.

101. *Taphrina sebastianae* (Sadeb.) Jacz.

Exoascus sebastinae Sadeb.

Sadebeck (120), Jaczewski (170), Saccardo 22:764, No. 5872.

Host: *Sebastiana brasiliensis* (Mull.) Arg. Leaf curl.

Asci: Polymorphic, narrow-cylindric, 90-130 x 8, or 70-80 x 6-9 and 2-3 broad at base; or clavate to oblong-ellipsoid, rounded or subtenuate, 50-90 x 9-20 (including stalk cell); stalk cells one or two.

Spores: Eight in ascus, ellipsoid, 5.5-6.5 x 4.5-5.

Distribution: Tubarao, Brazil.

102. *Taphrina sorbi* (Jacz.) n. comb.

Syn.: *Exoascus sorbi* Jacz.

Jaczewski (170).

Host: *Sorbus terminalis* Crantz. Spots on leaves.

Mycelium: Subcuticular.

Asci: Hypophyllous, clavate, truncate, 16-20 x 9-11; stalk cell flat, not inserted, diameter 6-8.

Spores: Usually eight in ascus, diameter 3.7-4; conidia 3.7 x 1.8.

Distribution: Caucasus.

103. *Taphrina bussei* v. Fab.

Syn.: *Exoascus bussei* v. Fab.; ? *Exoascus theobromae* Ritz. Bos.

Von Faber (129, 131), Ritzema Bos. (106), Jaczewski (170), Saccardo 22:764, No. 5869.

Host: *Theobroma cacao* L. Witches' brooms.

Mycelium: Intracellular.

Asci: On leaves only, amphigenous, 15-17 x 5.

Spores: Eight in ascus, ellipsoid, 2.5 x 1.7.

Distribution: Kamerun, South Africa. (Surinam?).

104. *Taphrina ulmi* (Fkl.) Johans.

Syn.: *Exoascus ulmi* Fkl.; *Exoascus campestris* Sacc.

Fuckel (17), Saccardo (41), Sadebeck (47, 73, 80, 93), Johanson (52), Rostrup (71), Giesenhagen (94, 108), Patterson (92), Palm (152), Jaczewski (170), Saccardo 8:819, No. 3351; 820, No. 3356.

Host: *Ulmus campestris* L., *U. glabra* Mill., *U. montana* With., *U. suberosa* Moench., *U. americana* L. Spots on leaves.

Asci: Cylindric, or oval, rounded, 12-20 x 8-10; stalk cell very broad, 3-8 x 15-20.

Spores: Eight in ascus, globose, diameter 3.5.

Distribution: Europe, North America.

DOUBTFUL SPECIES

1. *Taphrina githaginis* Rostr.

Rostrup (71), Sadebeck (73), Saccardo *10*:68, No. 4728.

Host: *Agrostemma githago* L. Swellings of stems and leaves.

Mycelium: Intercellular.

Asci: Ellipsoid, 48-58 x 30-45; no stalk cell.

Spores: Numerous, 4-6 x 2-3.

Distribution: Europe.

Apparently belongs in the Protomycetaceae.

EXCLUDED SPECIES

1. *Exoascus anomalus* Sacc. Is *Ascocorticium albidum* Bref.
2. *Taphrina candicans* Sacc. on *Teucrium chamaedrys* L. Not a fungus, but the effect of mite injury (Jaczewski, 170). Excluded by Giesenhagen (94).
3. *Taphrina cissi* Zoll. On *Cissus* sp. Never recognized by any student of the genus.
4. *Exoascus fulgens* (Cke.) Sacc. (*Ascomyces fulgens* Cke). on *Arctostaphylus* sp. An insect injury. Excluded by Giesenhagen (94).
5. *Taphrina marginata* Lamb et Fautr. On *Crataegus oxyacantha* L. Not a fungus, but injury due to Erineum mites. (Palm 152, Jaczewski 170.)
6. *Taphrina rhaetica* Volk. on *Crepis blattariodies* Vill. Belongs to Taphridium (Volkartia) of the Protomycetaceae. (Juel 157.)
7. *Taphrina umbelliferarum* Rostr. (*T. oreoselini* Massal.) Is *Taphridium umbelliferarum* (Rostr.) Lagerh. and Juel. (Juel 157.)
8. *Exoascus Quercus lobatae* Mayr. No fungus was ever seen.

THE UNIVERSITY OF KANSAS
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Two New Sunfish of the Family Centrarchidae from the Middle Pliocene of Kansas

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ABSTRACT: Two new species of *Centrarchid* fishes, *Chaenobryttus kansasensis* sp. nov., and *Pomoxis lanei* sp. nov., are described from specimens in the Kansas University Museum of Vertebrate Paleontology. Both species are from the diatomaceous marl bed, Middle Pliocene, Logan county, Kansas.

DURING the summer of 1924, Mr. H. T. Martin made his first visit to what is known as "Rhino Hill Quarry" in Wallace county, Kansas. While visiting this locality he discovered the white diatomaceous marl bed near the Marshall ranch. In this bed he found a few scattered fish scales and a few dicotyledonous leaves. This information was given to Dr. M. K. Elias of the Kansas Geological Survey. Doctor Elias in his intensive study of the geology of Wallace county, located a rich deposit of fossil fish in the diatomaceous marl, which is associated with a deposit of dicotyledonous leaves. The latter deposit was first opened in the summer of 1931 and only one day was spent collecting in this locality.

The quarry is located at sec. 7, T. 11 S., R. 37 W. in Logan county, about a mile east of the "Rhino Hill Quarry," which lies near the east line of Wallace county and is at the base of the diatomaceous marl. The marl was laid down in a large, deep, clear lake that existed during the middle Pliocene. It is interesting that under the lake bed is the old river channel filled with sand and assorted gravel, in which the "Rhino Hill" fauna is found in Wallace county.

The geology of this area has been fully discussed by Doctor Elias in "The Geology of Wallace County, Kansas," 1931, Kansas Geol.

12—6037

Surv. Bull., No. 18. An excellent detailed description of this diatomaceous marl is also given by Doctor Elias in Circular No. 3, Kansas Geol. Surv., 1931, "Diatomaceous Marl from Western Kansas, a Possible Source of Hydraulic Lime."

In collecting the specimens it was found that the procedure used in preserving many other types of fossils could not be used with those from the diatomaceous marl. The marl has been exposed to weathering, and has been attacked by the roots of plants from above which have caused it to crack in many pieces. In many places surface water has worked down through the joint planes, carrying sediment, and making it almost impossible to secure unweathered or complete specimens. There are also fine layers of clay intercalated in the marl, which hold moisture for a considerable time, so that upon exposure to the dry, hot climate of that area the clay dries rapidly, warps and checks, causing the thin layer of marl above to slough off, oftentimes destroying good specimens. The marl itself, if damp when first exposed to the atmosphere, likewise loses its moisture rapidly, causing it to crack and form fine laminae, destroying fossils in it. Great caution must be used in removing the fossils and special care must be taken to place them in a shaded area immediately upon removal. The fossils cannot be treated with gum arabic or shellac solution with any success, since this treatment causes them to break into many pieces.

Due to apparently close relationship of these forms to our modern fishes, it seems advisable at present to refer the following species to living genera, since many of the characters by which our modern genera are distinguished are those not found preserved in fossil forms. These species have been placed with living genera because they have certain skeletal characters in common. Future collecting may provide better preserved material which will further substantiate this association or give sufficient grounds for separation. Other species from this fauna will be described when sufficient modern material is available for comparative study.

Chaenobryttus kansasensis, sp. nov.

(Plate VI)

Holotype. No. 792F, University of Kansas Museum of Vertebrate Paleontology. Complete skeleton, lacking part of premaxillae.

Horizon and type locality. From the Diatomaceous Marl Bed, Middle Pliocene. Collected on sec. 7, T. 11 S., R. 37 W., Logan county, Kansas, by the University of Kansas Museum Expedition, summer of 1931.

Diagnosis. Body sunfish-shaped, oblong and slightly arched in front of dorsal fin. Vertebrae 13 + 16. D. X, 12; A. III, 8; V. I, 5. Length of attachment of anal fin less than one half of dorsal fin attachment. Longest anal and dorsal spines over half as long as soft rays. Longest dorsal spine equal to distance from snout to about the center of the eye. Neither pectoral nor ventral fins reaching anal fin. Maxillary, premaxillary, vomer, and pterygoid bearing teeth. Scales etenoid. Caudal fin emarginate.

Description of type. (See plate VI.) The specimen is that apparently of a young adult fish. Length of fish without tail, 94 mm. Length of head from end of snout to atlas, 31 mm. Head 3 in length; depth, 2⅝. Depth at caudal peduncle, 13 mm. The dorsal fin attachment is 35 mm. long. The lengths of dorsal spines are as follows: I, 8 mm.; II, 10 mm.; III, 12.5 mm.; IV, 13.5 mm.; V, VI, VII, VIII, IX, X, respectively, 14 mm. A distance of 18 mm. separates the posterior attachment of the dorsal fin from the caudal fin.

The head is badly crushed, but the dentition of the maxillaries and premaxillaries is very distinct. They are set with rows of small sharp conical teeth. On the anterior part of the maxillaries and premaxillaries in the outer row the canines are well developed. These are about three times the size of the small conical teeth. The vomerine and pterygoid teeth are small and conical. Only four branchiostegals are visible. The pectoral fin shows only ten rays, which are nearly hidden by the ribs. The ventral fin (I, 5) is so broken that only about half of the well-developed spine is present. The soft rays reach nearly to the first anal spine. The anal fin is well developed and is attached almost directly below the IX dorsal spine. The length of the attachment of the anal fin is 16 mm. and the posterior point of attachment is 17 mm. from the caudal fin. The anal spines are well developed and heavier than the dorsal spines. Their lengths are as follows: I, 11 mm.; II, 13 mm.; III, 15.75 mm. Three interneurals are present anterior to the dorsal spines.

Pomoxis lanei, sp. nov.

(Plate VII)

Holotype. No. 789F, K. U. M. V. P. Complete crushed skeleton lacking most of caudal fin.

Horizon and type locality. From the diatomaceous marl bed, Middle Pliocene. Collected on sec. 7, 11 S., R. 37 W., Logan county, Kansas, by the University of Kansas Museum Expedition, summer of 1931.

Diagnosis. Body sunfish-shaped, oblong, and symmetrical. Vertebrae 14 + 17. D. VII, 15; A. VI, 12; V. I, 5. Anal fin nearly as long as dorsal. Longest anal and dorsal spines over half as long as soft rays. Scales ctenoid.

Description of type. Complete impression of a small sunfish, with the exception of the tip of the caudal fin; many of the bones and fin rays present. The skull is badly crushed. The dentary and premaxilla are covered by rows of sharp conical teeth. The vomer, palatines, pterygoids and pharyngeals are missing or so crushed that they cannot be studied. Length of the head from the tip of the premaxilla to the posterior border of the opercular, in line with the vertebrae, 25 mm. Only three branchiostegals are visible. The pectoral fin is so folded under the body that it is impossible to study it in detail. The ventral fin (I, 5) is attached 11.5 mm. anterior to the anal fin. The spine is well developed, being 9.5 mm. long. The soft rays just reach the first spine of the anal fin. The length of basal attachment of the anal fin is 20.5 mm. The first anal spine is attached directly under the attachment of the fourth dorsal spine. Anal spines I and II are rather slender. The lengths of the anal spines are as follows: I, 3.5 mm.; II, 5 mm.; III, 6 mm.; IV, 9 mm.; V, 10.5 mm.; VI, 12 mm. The first soft rays of the anal fin are 15 mm. long. The soft anal rays reach only to the center of the caudal peduncle. The dorsal fin has a basal attachment of 22 mm. The soft rays are longer than the longest dorsal spines. The lengths of the dorsal spines are as follows: I, 4 mm.; II, 6 mm.; III, 10 mm.; IV, 11 mm.; V, VI and VII, respectively, 13 mm. Six interneurals are present anterior to the first dorsal spine. Vertebrae (impressions) 14 + 17. Only four vertebrae are actually present. The greatest depth of 26 mm. is just anterior to the dorsal fin. Length of fish to last caudal vertebrae is 70 mm. The skeleton is that of a young fish.

The paratype is the skeleton of a still younger fish 45 mm. in length to the last caudal vertebrae. The caudal fin is entirely lacking. The skeleton is nearly complete except for the badly crushed condition of the head. Small conical vomerine teeth are present. The ventral, anal and dorsal fins are the same as in the holotype. The spinous rays have the same proportionate length. Pectoral fin shows at least ten rays. Vertebrae are complete, being 14 + 17. The eye is contained four times in the length of the head.

Remark. This species is named for Dr. H. H. Lane, under whose guidance the expedition worked the summer of 1931, and who has offered many helpful criticisms and suggestions.

PLATE VI

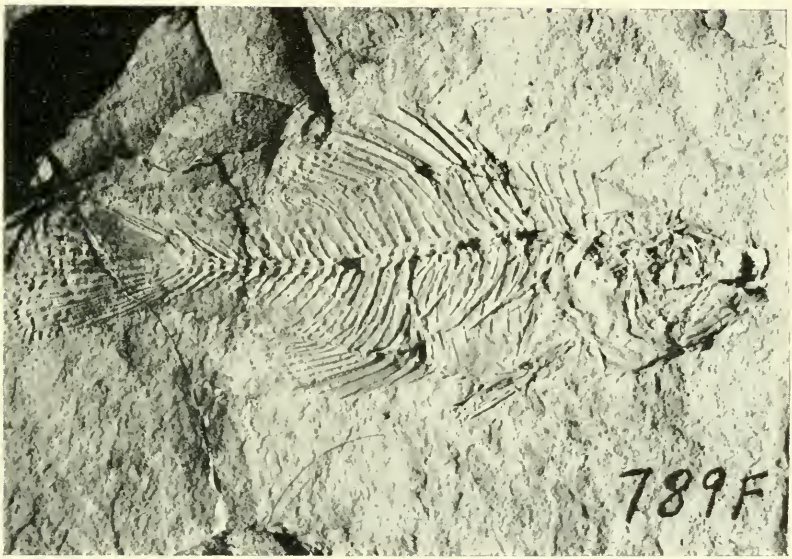
Chaenobryttus kansasensis, sp. nov., nearly complete skeleton, K. U. Mus. Vert. Paleo. No. 792F. Approximately ⅞ natural size. See text for measurements and description.

PLATE VI

PLATE VII

Pomoxis lanei, sp. nov., nearly complete skeleton, K. U. Mus. Vert. Paleo. No. 789F. Approximately natural size. See text for measurements and description.

PLATE VII



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The Family Apioceratidae (Diptera) in North America*

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ABSTRACT: Notes on most of the type series, keys to all species, and additional distribution records are given for the known North American species. The following new species of *Apiocera* are described: *trimaculata, caloris, aldrichi, beameri, clavator, interrupta, notata, convergens, martinorum* and figures are given of genitalia and other characters. There are seventeen described species in this family in North America.

IN a recent review of the genus *Apiocera* (4) the writer redescribed the two previously known North American species of this genus and added one new species. Through the kindness of the late Dr. J. M. Aldrich, United States National Museum, it has been possible to study a number of additional specimens representing six new species of this genus. During a recent trip for the study of the types of Bombyliidae† it was possible to examine also all of the type specimens of the family Apioceratidae which still exist in North American museums. A few notes on these have also been included. These records have extended the range of several species and our knowledge of this unusual family. The species described here bring the total number of North American species to seventeen and the total known for the world to twenty-five.

* A study of the material in the Francis Huntington Snow Entomological Museum, University of Kansas, the United States National Museum and several others. This is Contribution No. 415, from the Department of Entomology, Kansas State College.

† The writer is indebted to the directors of the Bach fund for funds to permit the examination of these types. The author is also indebted to the following persons for the loan of personal collections or specimens in their care: Dr. J. M. Aldrich, Dr. R. H. Beamer, Messrs. E. P. VanDuzee, C. H. Martin, J. Wilcox, E. R. Tinkham, F. M. Hull and E. T. Cresson, and to his wife for making the illustrations which are given here.

RHAPHIOMIDAS

A study has been made of a few specimens of each of the described species of this genus and of the types which still exist. The key given below is adapted from Townsend (5):

1. First anal cell open widely ..... *Apomidas trochilus* Coq., 188
   First anal cell closed (*Rhaphiomidas*) 2
2. Abdomen wholly brown, wings with a smoky tinge, antennae blackish. . *episcopus* O. S., 188
   Abdomen not wholly black; wings hyaline, antennae yellowish or reddish, at least on the third joint 3
3. Abdomen almost wholly yellow ..... *xanthos* Townsend, 189
   None of the abdominal segments entirely yellow, the second and fourth each partly yellow, partly blackish 4
4. Ground color of abdomen yellowish, only the front border and a median spot on second to fourth segments blackish; bristles of legs and scutellum yellowish. . *acton* Coq., 188
   Ground color blackish, only the hind border of second to fourth segments yellowish; bristles of hind border of scutellum and middle and hind legs blackish, *mellifex* Townsend, 189

1. *Apomidas trochilus* Coq. (2)*

This species is included in the key on account of its great similarity to *Rhaphiomidas*. The type female in the United States National Museum lacks the antennae and is greasy. It is in all respects like *R. acton* or *xanthos* except in the open first and anal cell. A male intermediate in this character is mentioned under *R. acton*. It appears that this single character is hardly sufficient grounds for generic segregation. No other specimens appear to have been collected or recorded and additional material will probably be necessary before the exact generic status can be determined.

1. *Rhaphiomidas episcopus* O. S. (3) (5)

The type female in the Museum of Comparative Zoölogy is very greasy, but so far as is visible, the identification and description given by Townsend from fresh specimens is correct. The black pile, mentioned by Osten Sacken, on the last three segments consists of restrose hairs similar to those found on female *Apiocera*. The antennae are like those of *acton* in size and shape. There is a female from the Townsend collection in the University of Kansas collection taken at El Taste, Baja Cal., Sept. '95 (Eisen).

2. *Rhaphiomidas acton* Coq. (1)

The type male is in the United States National Museum. The several specimens which have been seen vary considerably in respect to the amount of black on the abdomen. In a typical male

* Numbers refer to literature cited.

specimen the antenna measured first joint, 0.65 mm.; second joint, 0.25 mm.; third joint, 1.85 mm. The third segment is elongate oval in shape.

The following specimens have been seen:

Three males, two females, Cajon, Cal., July 24, 1930 (T. F. Winburn and R. H. Painter, coll.); several specimens "California." A male, Mohave Desert, Cal., July 20, 1930 (C. H. Martin, Coll.), is apparently this species. The first anal cell is narrowly open and in this respect is about half way between the typical *acton* and that in the type of *A. trochilus* Coq. The genitalia and other structures are identical with other males of *acton;* the amount of black coloration on the abdomen is a little less than usual.

3. *Rhaphiomidas xanthos* Townsend (5, 6)

The type of this species was destroyed in the San Francisco fire in April, 1906. There are, however, three males in the Snow collection of the University of Kansas which were received from Townsend and appear to belong to the type series. They are labeled "type" in the same handwriting as are the specimens of *mellifex.* The locality is given as "El Taste, B. C. Sept. (Eisen)." A single teneral male from the type locality is in the National Museum. The type series consisted of one male mentioned at the first of the description and ten others mentioned later. These were said to be from San José del Cabo. The two localities are very close together and it appears that the author designated the town rather than the mountain as the type locality.

The only specimens seen in addition to those reported by Townsend and Colquillett were a male and female, State College, New Mexico, Sept. 23 (W. J. Bearg). The genitalia are different from *mellifex* and *acton,* but the antennae are like the former species in size and shape. In the New Mexico specimen the first joint of the antenna measured 0.5 mm.; second, 0.35 mm.; third, 1.2 mm. The third joint is "flask-shaped" with the neck near the second joint. In one of the Townsend specimens the anal cell is narrowly open in one wing and closed in the other. In both the other specimens it is closed and more or less petiolate.

4. *Rhaphiomidas mellifex* Townsend (5, 6)

The type of this species was also destroyed in the San Francisco fire. In the Snow collection at Kansas University there are two females which apparently belong to the type series. Both are marked

"type" in the same handwriting as are other types in the Townsend collection there. These two specimens are labeled "El Taste, L. Cal., Sept." This locality reference is evidently to a mountain very near San José del Cabo, the type locality mentioned in the original description. In the Snow collection there is also a female, San Jacinto Mts., Cal., 7-21-29 (L. D. Anderson), which is identical with these others except that the third joint of the antennae is a little longer. In this species this joint is like *xanthos*, thus shorter and broader than in *episcopus* or *acton* (text, figure 1).

Genus *Apiocera*

In this genus the males and females sometimes differ appreciably in coloration. The males are easily distinguished either on the basis of abdominal coloration or by the structure of the genitalia. The females of several species, however, look much alike and it is only by comparative study that it has been possible to identify these with certainty. The shape and vesture of the ninth sternite and tergite and of the eighth somite provide excellent characters for distinguishing the males of the several species. These structures are figured for all the North American species. The details of head, thorax and wings appear to present little of use in distinguishing the species. The structure of the vesture was discussed in a previous paper (4). The key given below is an attempt to provide for identification of both males and females where possible. Main dependence must be placed on the structure and coloration of the males for correct determinations (Plate VIII).

KEY TO THE SPECIES OF APIOCERA IN NORTH AMERICA

1. Metapleura with a more or less conspicuous tuft of hair in front of the spiracle.. 2
   Metapleura bare or uniformly short pilose 5
2. Dorso-caudal angle of mesopleura with a tuft of white hair (see also *martinorum*) *trimaculata*, n. sp., 195
   Dorso-caudal angle of mesopleura with three or four strong setae 3
3. Setae of body and legs largely white, hairs of thoracic dorsum white, *caloris*, n. sp., 194
   Setae of body and legs largely black, hairs of thoracic dorsum white 4
4. Abdominal segments 2, 3, and 4 of male banded black and white..*aldrichi*, n. sp., 193
   Abdominal segments 2 and 3 of male spotted black and white or forming irregular bands as in *haruspex* .....*beameri*, n. sp., 198
5. Dorso-caudal angle of mesopleura with three or four strong black setae (see, also, *augur*) .....*clavator*, n. sp., 196
   Dorso-caudal angle of mesopleura bare or slightly hairy..... 6
6. Most of short hairs on mesonotum and male genitalia black in color; setae mostly black 8
   Most of short hairs white on mesonotum, and male genitalia; setae white 7
7. Abdominal spots convex above, straight below; pulvilli usually more than half as long as claws; two black spots on each side in females .....*interrupta*, n. sp., 192
   Abdominal spots quadrate; pulvilli about half as long as claws; three black spots on each side in female .....*bilineata* Painter, 191

8. Dorsum of abdominal segments 3 and 4 in male broadly black 9
Black on segments 3 and 4 of male forming spots 10
9. Male genitalia brown, ninth tergite notched at apex .....*haruspex* O. S., 191
Male genitalia black, ninth tergite not notched at apex .....*notata*, n. sp., 199
10. Thorax mostly gray pollenose; dark brown of abdominal segments not extending across dorsum in male; sometimes almost lacking or confined to two small triangular spots on segments two and three .....*augur* O. S., 192
Thorax brownish pollenose; in male two white stripes the length of the abdomen show conspicuously against the dark brown, three black, subquadrate spots on each side in female .....*convergens*, n. sp., 196
Thorax gray or brownish pollenose; in the male a central black stripe and lateral black stripes constricted or interrupted at the base or apex of segments three and four; usually four triangular spots on abdomen of female.....*martinorum*, n. sp., 197

1. *Apiocera bilineata* Painter (4)

Drawings of the male genitalia of this species are shown on Plate VIII. In studying over the specimens previously reported the long hairs on the ventral lobe of the genitalia have been found to be black in eight specimens, orange-yellow in four and with some of each color in seven specimens. Variation in this character has been found in other species, notably *haruspex* O. S. A male and a female in the Jas. S. Hine collection from Bill Williams Fork, Ariz. (F. H. Snow), appear to be the same species, but both specimens lack the genitalia. In the male the pulvilli are longer than usual for this species and the abdominal stripes are hardly interrupted at the incisures. It is possible that these may represent another species, possibly an undescribed one. One male, White Sands, N. Mex., June 30, 1932, R. H. Beamer collector; two females, White Sands, N. Mex., July 23, 1933 (W. Benedict), in the Kansas University collection, belong to this species. There is also a male in the same collection from Cameron Co., Tex., August 3, 1928, that appears to belong to *bilineata*. It differs from the other specimens in a few minor characters.

2. *Apiocera haruspex* O. S. (3, 4)

This species appears to be the most widely distributed of those in North America. The type has been studied and it agrees with the previous descriptions and the genitalia drawing given here (Plate VIII). Specimens have been seen from the following additional localities:

CALIFORNIA: 1 male, Yosemite, August 3, Hall and Hall coll., in J. Wilcox collection; 1 female, Mt. Wilson, August 30; and 5 males, 1 female, Monrovia Canyon, August 16, 24, 29, 31 and September 1, C. H. Martin collector; 3 males, Beautivista Canyon, July 5, C. H. Martin collector, and in his collection; 1 male, Pasadena, August 1, 1898, Grinnell (United States National Museum); 1 male, Tuolumne Co., Cal., July 29, 1926, E. R. Leach; 1 male, 2 females, San Diego Co., Cal., July, 1891, F. E. Blaisdell; 3 males, Idyllwild, Cal., July 2 to 8, 1928, E. C. Van Dyke; 1 male, Oroville, Cal., July 15, 1926, H. H. Keifer

(Cal. Acad. Sci.). Two males, 1 female, Nipomo, July 24, 1935; 1 male, Cajon Pass, August 1, 1935; 1 female, Indio, August 8, 1935; 2 females, San Diego, August 7, 1935, J. Russell collector; 1 female, Idyllwild, August 3, 1935, E. I. Beamer collector; 3 males, 6 females, Cuyama Ranch, July 23, 1935, J. Russell, Jack and R. H. Beamer, collectors. (In Snow Collection).

IDAHO: One male, one female, Lewistown, August 2, 1912 (U. S. N. M.); five males, three females, Lewistown, Idaho, July 14-22, 1925, C. L. Fox collector.

WASHINGTON: One male, Eastern Washington (U. S. N. M.).

WYOMING: Kahlotus, July 30, 1924, M. C. Lane, collector (J. Wilcox collection).

BRITISH COLUMBIA: One male, Oliver, July 24, 1923, P. N. Broom, collector (U. S. N. M.).

OREGON: Three males, Adrian, July 22, 1934, C. H. Martin, Dorothy Martin.

3. *Apiocera auger* O. S. (4)

The Bembecine wasps, mentioned in the paper (4) as catching specimens of this species, have been determined by Richard Dow as *Stictiella tennicornis* (FOX). Drawings of the genitalia of *A. augur* are shown in Plate VIII. The following additional specimens of this species have been identified:

TEXAS: Presidio, 2 females, July 29, 1928, 1 male, 1 female, August 16, 1929 (E. R. Tinkham collection); 1 male, Fort Stockton, July 18, 1927, L. A. Stephenson collector in Kansas University collection; 1 male, Brewster Co., June 24, 1929, J. B. Parks collector in J. Wilcox collection.

NEW MEXICO: 1 male, Mesilla Park, May 21, Cockerell (U. S. N. M.); 1 male, Eddy Co., N. Mex., July 11, W. Benedict (Snow Coll.).

A male and a female collected by F. M. Hull on Galveston Island, June, 1926, appear to belong to this species. The male genitalia differ only in some details which may be due to position. The abdomen is rubbed but seems to have had the typical pattern. Both sexes, however, have small spines on the dorsocaudal angle of the mesopleura. This is the most easterly record of this family.

4. *Apiocera interrupta*, n. sp.

A pale, white pollenose species with white setae and with lateral rows of six abdominal spots which are straight on the lower and convex on the upper margin. Metapleurae and mesopleurae bare. Genitalia pale brown, similar to *bilineata*. Length, 19 mm.

Male. Ground color, pale brown or yellow; mesonotum and last antennal joint dark brown or blackish. Pollen entirely white with perhaps a trace of a darker pattern on the mesonotum. All setae and pile white except for a little blackish or brownish pile on the underside of the male genitalia. A series of lateral spots commenc-

ing at the second segment and diminishing in size posteriorly are black on segments two to four and brownish on five to seven. These spots are convex above and straight in outline below, but vary somewhat in size and shape. They are in approximately the same position as in *bilineata*. The genitalia are very similar to *bilineata*, differing principally in the shape of the ninth sternite, less acute at the end and with a broader incision on the inner margin. Pulvilli about three fourths the length of the claws, wings hyaline, veins yellow.

Female. Similar to male; retrose hairs on the last four abdominal segments white or yellowish. Spines of ovipositor brown. The black spots on abdominal segments two and three are subquadrate, and there is a trace of a brownish spot on the sides of segment four.

Holotype. Male, Los Angeles, Cal., D. W. Coquillett collection.

Allotype. Female, Los Angeles, Cal., D. W. Coquillett collection.

Paratypes. Male, San Diego Co., Cal., D. W. Coquillett collection. (In United States National Museum, Cat. No. 51432) 3 females, Indio, Cal., August 5, 1935. (Jean Russell and Jack Beamer.) (In Snow collection.)

5. *Apiocera aldrichi*, n. sp.

A robust, densely white pilose and pollenose species with the dorsum of abdominal segments two, three and four jet black in ground color in the male. There is a subtriangular black spot in the female in the center of each side of segments two and three. Setae mostly black. Metapleura with a conspicuous tuft of hair in front of spiracle; dorsocaudal angle of mesopleura with three or four strong setae. Length, 23 mm.

Male. Ground color of body and head black, last two joints of antennae, palpi, first and second tibiae, and abdomen beyond the fourth segment, brownish. Except for the genitalia and parts of the dorsum, the body is clothed with a thick mat of pollen consisting of minute curly hair, and in many places with erect thin hairs. The latter are especially abundant and long on the lower part of the head, coxae and first four abdominal segments. Dorsum of thorax brown pollenose with short brown pile and streaks of gray pollen which form the usual pattern. Setae of body and legs black; of head white.

Abdomen white pollenose; segments two, three, and four with quadrate black spots which are black pilose. In front of each of these, the margin is grayish, behind white. Separated from these

spots and on the same segments are smaller subquadrate blackish spots along the ventrolateral margins of the tergites. Dorsum of segments one and eight brownish. Genitalia brownish, pile black. Wing hyaline.

Female. Similar to male. The pattern on the thorax is less prominent and the body setae are partly white. The abdominal pile is not so long as in the male. Abdomen white pollenose; brownish in center of dorsum with an ill-defined subtriangular spot on each side of segments two and three. A similar spot is faintly visible on segment four. The quadrate spots on the ventrolateral margins of abdominal tergites two, three and four are faintly visible. Segments six, seven, and eight, and apex of five shining brown; clothed with retrose black hairs on fourth and following segments.

Holotype male and *allotype* female, Yuma, Ariz., June 26, 1917, J. M. Aldrich, collector. (In United States Nat'l Museum, Cat. No. 51433.)

Paratypes. Eight males, 1 female, same data as type; 1 male, Indio, Cal., June 6 (Dyar and Caudell); 1 female, Los Angeles, Cal. (collection D. W. Coquillett); 1 female, San Diego Co., Cal. (Coquillett collector); 1 male, S. E. San Bernardino Co., Cal., June 15, 1930 (J. Wilcox collection); 2 males, Florence, Ariz., May 30, 1903 (collection of Acad. Nat. Sci. Phila.); 2 males and a broken female (not a paratype), Bill Williams Fort, Ariz., F. H. Snow (Kan. Univ.); 2 males, four females, Coachella, Cal., May 25, 1928, E. C. Van Dyke; 1 male, Phoenix, Ariz., July 17, 1932, H. Gentry (Cal. Acad. Sci.).

Doctor Aldrich stated that most of his specimens were collected across the Colorado river from Yuma on the California side.

6. *Apiocera caloris,* n. sp.

A more slender, smaller species than *haruspex* or *aldrichi,* but resembling them in general appearance and with different genitalia in the male. Metapleura with a conspicuous tuft of hair in front of the spiracle; dorsocaudal angle of mesopleura with three or four strong setae. All setae largely white. Length, 18 mm.

Male. Ground color of body and head blackish-brown; basal points of antennae, palpi, tibiae, and apical two thirds of abdomen yellowish-brown. Pollen, all pile, and setae of body and head white; a few black setae on tarsi and apex of tibiae. Abdominal segments two, three, and four with central spots bare of pollen and hence appearing brownish or blackish. These spots on segments three and

four occupy most of the dorsum of the segments. On segment two the spot is of the same shape as on this segment of *haruspex* (4, fig. 6) except that the anterior border of white pollen is wider and the posterior border is not interrupted in the center. Genitalia brown, white pilose. Wings hyaline, veins brown.

Female. Similar to male, all pile and hairs, except the retrose hairs on abdominal segments six and seven, white. Abdomen white pollenose a large subtriangle black spot on the center of each side of segments two and three.

Holotype. Male and *allotype* female. Tinijas Altas, Southern Arizona, 1905, W. J. McGee, collector (in U. S. N. M. Cat. No. 51434).

Paratypes. Two females, same data.

All of these specimens have been in liquid (alcohol?) and one female appears to be teneral. The male genitalia are very distinct, however, and the body characters are different from any other species studied. Hence the species should be recognizable even though the specimens from which the description is drawn are poorly preserved and their coloration perhaps not normal.

7. *Apiocera trimaculata,* n. sp.

A densely white pilose, white pollenose, species with three somewhat diamond-shaped, black spots on abdominal segments two, three, and four. A tuft of hair on the metapleura in front of the spiracle, another which is not intermixed with setae on the mesopleura in front of the wings. Setae except on the tarsi white. Length, 17 mm.

Male. Ground color black, palpi yellow, tarsi and genitalia brownish. Clothed throughout with white pollen; a faint pattern of brownish pollen on the mesonotum. Pile white, especially dense on the abdomen, front coxae, and lower part of head. The pile is partly black on the black abdominal spots. These latter are as follows: segment two, with a central diamond-shaped spot with a triangular one attached on each side by the apex to the central spot; segment three, a central diamond-shaped spot occupying most of the dorsum of the segment; segment four, a smaller diamond-shaped spot. In addition, on the ventrolateral margins of segments three and four there is an indistinct ovoid black spot; a similar one shows very faintly on segment two. Genitalia white pollenose and pilose; notch on the tip of the ninth sternite a little more pronounced than in *caloris,* which it resembles.

Holotype. Male, San Diego Co., Cal., collection of D. W. Coquillett. (In United States National Museum, Cat. No. 51435.)

The species is most closely related to *caloris,* but in genitalia and other characteristics it is distinct.

8. *Apiocera convergens,* n. sp.

A moderately pilose species with two white pollenose stripes which converge on segments five and six and show conspicuously against the black and brown abdomen of the male. Metapleura bare, mesopleura with thinly scattered hairs, genitalia and femora mahogany brown. Setae black. Length, 18 mm.

Male. Ground color black; palpi yellowish, antennae, femora and posterior part of abdomen dark brown, tibiae light brown. Pile, white, the short hairs on thoracic and abdominal dorsum, and on genitalia, black. Pollen white, with grayish-brown patterns on the thoracic and abdominal dorsum. The abdominal pattern is complicated. A slender central triangle with its base on segment two, and apex on segment five, has the base of each segment brownish, the apex of each one black, and is interrupted at the extreme apices of segments two and four by a narrow white band. This central triangle is separated from two rows of conspicuous black lateral spots by a white stripe on each side. These spots are subquadrate and become progressively larger from segment two to four, and smaller from segment five to seven. There is in addition faint blackish stripes on the extreme ventrolateral margins of the tergites. The remainder of each segment is white pollenose. Pulvilli about as long as the claws. Wings hyaline, veins brown.

Female. Similar to male, but abdominal pattern apparently confined to subquadrate black spots on the sides of segments two, three and four. (The specimens are greasy and rubbed.) Retrose hairs on last three abdominal segments, and those of the dorsum of thorax and abdomen black.

Holotype. Male and *allotype* female, "Cal.," C. W. Riley collection. (In United States National Museum, Cat. No. 51436.)

Paratypes. Male and female, same data.

The male specimens were labeled *Apiocera haruspex* O. S. by Coquillett.

9. *Apiocera clavator,* n. sp.

A small species resembling *bilineata* and *interrupta* in abdominal markings, but darker, and with entirely different genitalia. Meta-

pleura bare; mesopleura with a tuft of black setae in front of the wings. Pulvilli about two thirds as long as the claws. Setae of body mostly black. Length, 16 mm.

Male. Ground color black or very dark brown, palpi yellow, tibiae and tarsi light brown. (Third joint of antennae missing.) Pollen white on head, and below the level of the wings; brownish-gray on mesonotum and abdominal dorsum, but lighter in color along the apices of the segments. Pile is white on the parts that are white pollenose, black on the mesonotum, abdominal dorsum, genitalia, tibiae, and tarsi. Setae black, except white on head, femora, and coxae. The velvety black abdominal spots on each side of the second to seventh segments are subquadrate, but somewhat convex above. The one on the fourth is the largest; they diminish rapidly in size on the segments caudal to the fourth but to a less extent cephalad. There are faint oblong spots on the ventrolateral margins of tergites two to five, brownish in color and largest on segment four. Wings hyaline, veins brown. Genitalia much shorter than in the other species.

Holotype. Male, state of Colima, Mexico, L. Conradt, collector. (In United States National Museum, Cat. No. 51437.)

10. *Apiocera martinorum,* n. sp.

A moderately pilose species with five blackish spots on each of the segments two, three and four in the male. On segment four these tend to coalesce. Metapleura and mesopleura pilose, the pile on the former frequently reduced or absent. Genitalia and tibiae brown, setae mostly black. Length, 19 mm.

Male. Ground color black; palpi yellowish, tibiae, tarsi, genitalia, and posterior margins of last three segments brown. Pile white, except the short hairs and pile on the metanotum, genitalia and the black spots on the abdomen which are black. The setae on the antennae, head, and prothorax white. Pollen white with grayish pattern on the thoracic and abdominal dorsum. On the abdomen the pattern is as follows: first segment brownish with two white spots on each side; second segment brownish at base, to which the four blackish spots are more or less connected; the remainder of the segment white; third segment with the four spots separated by white pollen; on the fourth segment the inner lateral spots are broader at the apex and almost unite with the others on this margin of the segment. The last three segments white pollenose with a central

brown dorsal spot which may be due to being rubbed. Pulvilli about as long as claws. Wings hyaline, veins dark brown.

Female. Similar to male, but abdominal pattern consisting of a subtriangular black spot on the center of each side of segments two and three, and an indistinct spot in the same place on four. There are also indistinct stripes on the extreme ventrolateral margins of the tergites. The first two antennal segments and femora brownish, the tibiae and last three abdominal segments light brown. Most of the pile and hair on the first four abdominal segments white.

Holotype. Male, Adrian, Ore., July 22, 1932. Dwylee river sand dunes, Dorothy Martin, collector. (In C. H. Martin collection.)

Allotype. Female, Adrian, Ore., July 21, 1934. C. H. Martin, collector. (In C. H. Martin collection.)

Paratypes. Seven pairs, 21 females, 66 males. Adrian, Ore., July 22, 24, 25, 31, Aug. 4, 11; Roswell Bench, Parma, Idaho. Aug. 4, 5, 1934. (Chas. H. and Dorothy Martin.)

In the male, segment four of the abdomen is sometimes almost entirely black; there is variation in the size and shape of the black spots. The genitalia of the male differs from that of *convergens* in various proportions and in the presence of a distinct notch at the apex of the ninth tergite. In both sexes there is considerable variation in the distribution of the black and white setae and in the amount of pile on the metapleura. The female differs from those of both *haruspex* and *augur* by having the black spots near the center of the sides of the segments rather than at the posterior angles. The female of *convergens* has subquadrate, rather than subtriangular spots. This species is named for the collectors—Dorothy and Charles H. Martin.

11. *Apiocera beameri,* n. sp.

Abdominal pattern of male similar in pattern to that of *haruspex* from which it differs in characters of genitalia and in the presence of a tuft of hair on the metapleura in front of the spiracle and several setae on the dorso-caudal angle of mesopleura. Length, 22 mm.

Male. Ground color of body and head black, antennae, palpi, tibiae, and abdomen beyond segment four dark brown. Body and head, except genitalia and parts of dorsum, clothed with a thick mat of pollen or minute curly hair. Palpi, front, prothorax, coxae, femora, and abdomen clothed with erect thin, white hairs. Dorsum of thorax grayish and brown pollenose, forming the usual pattern. Setae of head white, of coxae mostly white, of thorax mostly black,

of femora and tibiae black. Abdomen white pollenose; bare, black spots on the dorsum forming a pattern similar to that of *haruspex;* segment one brownish in the center and along the posterior margin; segment two brownish on the anterior border, the black crossband expanded broadly in the center to the posterior border and also expanded laterally, the remainder of the dorsum snow white; segment three mostly black, the anteriolateral and posteriolateral margins brownish; segment four black, the anterior margin narrowly brownish, the posterior white. Segments five, six, and seven mostly white. A quadrate black spot on the ventrolateral margins of tergites two, three, and four. Genitalia dark brown, pile black. Wings hyaline.

Female. Almost identical with *aldrichi.* The single female available is somewhat greasy. There appears to have been a black triangular spot on each side of segment four as well as on segments two and three. The retrose hairs on the fourth and following abdominal segments are mostly white where in *aldrichi* they are mostly black.

Holotype. Male, Cuyama Ranch, California, July 25, 1935 (R. H. Beamer), in Snow collection.

Allotype. Female, Cuyama Ranch, California, July 25, 1935 (R. H. Beamer), in Snow collection.

Paratype. Male, Cuyama Ranch, California, July 25, 1935. (Jack Beamer), Snow collection.

This species is closely related to *aldrichi,* but has a different abdominal pattern in the male and different male genitalia. The species is named in honor of the collector, Dr. R. H. Beamer.

12. *Apiocera notata,* n. sp.

Abdominal pattern of male similar to that of *haruspex,* from which it differs in having the genitalia black and lacking the notch on the ninth tergite. Length, 20 mm.

Male. Ground color black to very dark brown; palpi, tibiae, and tarsi lighter brown. Head and lower parts of body and femora gray pollenose, thinly white pilose, dorsum of thorax and scutellum brown pollenose, short black pilose with streaks of grayish pollen forming the usual pattern. Setae of head and four front coxae mostly white, of remainder of body and legs black. Abdomen gray and brown pollenose with black bare spots which form a pattern similar to that of *haruspex.* First segment brown pollenose lighter on each side, darker in center, a tuft of white pile at the anterior corners and of black pile at the posterior corners; second segment brown pollenose

on the anterior margin, white on the posterior margin, separated by three connected black triangles; third segment with two brown spots along the anterior margin, the remainder black; fourth segment black with two small white spots on the anterior margin; fifth and sixth white pollenose, seventh mostly brown pollenose on the dorsum; laterally the usual three quadrate black spots, that on the fourth joined to the black band posteriorly. Most of the pile of the abdominal dorsum short, black. Genitalia blackish to dark brown, pile black. Wings hyaline.

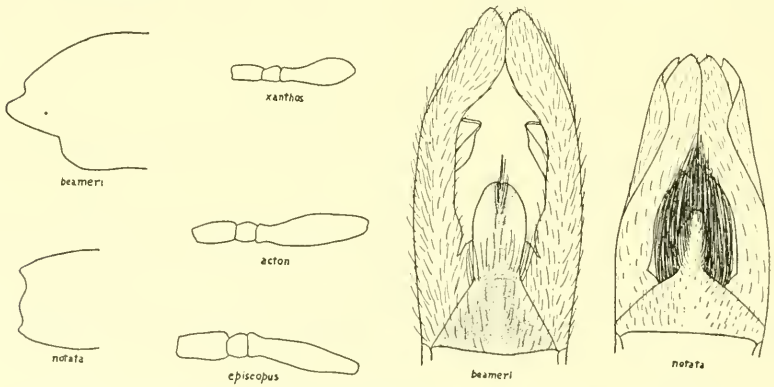
Female. Almost identical with the female of *haruspex.* In the single specimen at hand the triangular black spots on the abdominal segments are larger than usual in *haruspex* and on segments three and four are confluent with the black quadrate spots on the ventrolateral margins of the tergites. Segments seven and eight are much darker in ground color than usual with *haruspex,* the knob at the apex of eight is black rather than brown.

Holotype. Male, Campo, Cal., August 10, 1935 (E. I. Beamer), in the Snow collection.

Allotype. Female, Campo, Cal., August 10, 1935 (Jean Russell), in Snow collection.

Paratypes. Two males, same locality and date (E. I. Beamer and Jean Russell, collectors), in Snow collection.

This species is related to *haruspex,* but the genitalia of the male is very different.



TEXT FIGURE I. Ventral aspect of genitalia and lateral aspects of apices of the ninth tergites of *Apiocera beameri* and *notata.* Lateral aspects of antennae of *Rhaphiomidas xanthos, acton* and *episcopus.*

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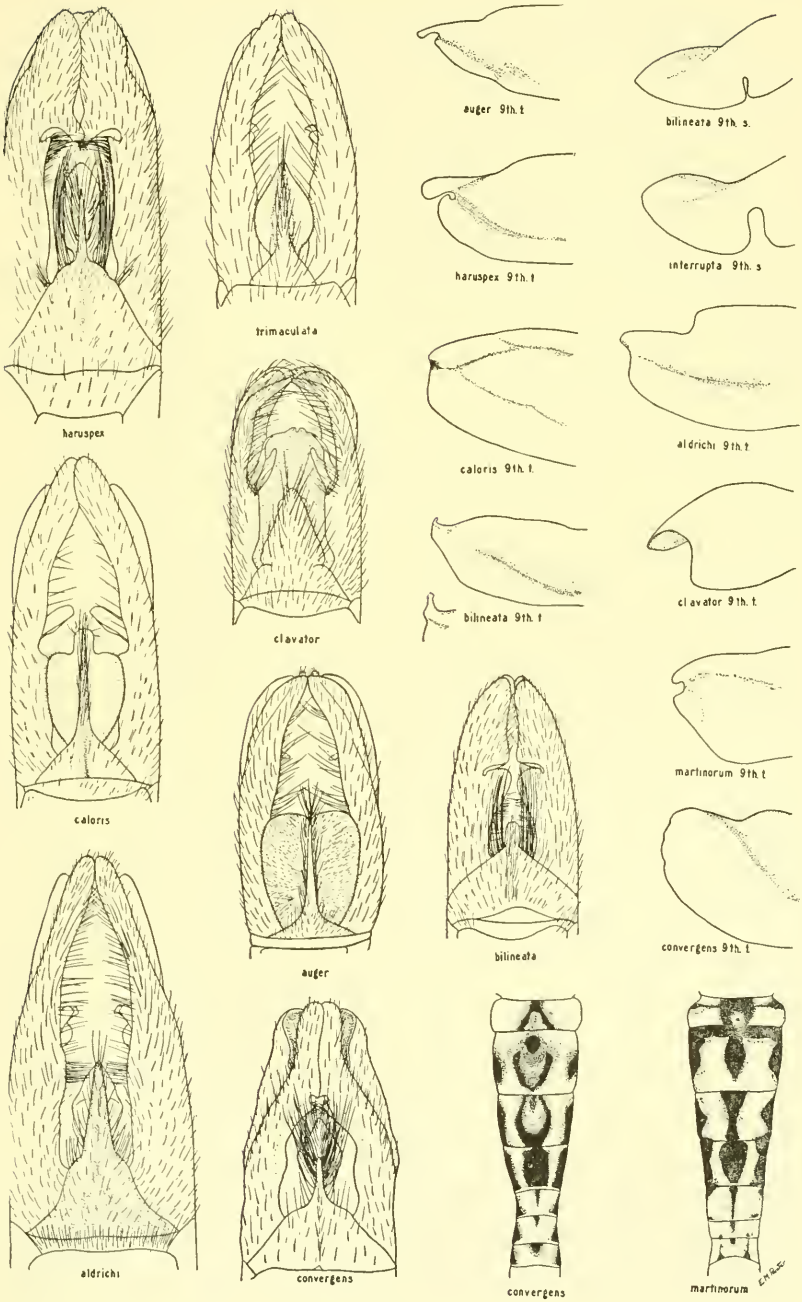
PLATE VIII

Ventral aspect of genitalia of *Apiocera aldrichi, caloris, haruspex, convergens, clavator, trimaculata,* and *bilineata* and ventrolateral aspect of the ninth sternite of *interrupta* and *bilineata.* Lateral aspects of the ninth tergites of *bilineata, caloris, haruspex, augur, convergens, martinorum, clavator* and *aldrichi.* Diagrams of the dorsal abdominal pattern of *convergens* and *martinourm.* All the genitalia drawings are made at the same magnification, except that of the tip of the ninth tergite of *bilineata.*

PLATE VIII


haruspex
trimaculata
auger 9th. t
bilineata 9th. s.
haruspex 9th. t
interrupta 9th. s
caloris 9th. t.
aldrichi 9th. t
bilineata 9th. t
clavator 9th. t.
caloris
clavator
martinorum 9th. t
auger
bilineata
convergens 9th. t
aldrichi
convergens
convergens
martinorum

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The Morphology of the Carolina Mantis*

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ABSTRACT: This study is a detailed morphological consideration of the skeleton of the Carolina mantis. It is not a topographical description, but an analysis of the skeletal structures in relation to function, origin, and development. The head skeleton has been reinterpreted. Some new terms are proposed, and others are given clearer meanings. The discussion is supplemented by eight plates of penned drawings.

INTRODUCTION

MOST of the recent work in insect morphology, especially that of this country, is of a comparative nature. The purpose of such work is the drawing of tentative concepts, a purpose of primary value for it furnishes us the broad outlines for the study of insect structures. In making an illustration the draftsman does not begin with the details of one portion and progress to another; he "blocks out" the fundamental lines first, then proceeds with the grosser features of particular areas, and finally considers the details. Comparative analyses of insect structures give us the fundamental lines, but it should be remembered that these lines are tentative. Comparative analyses, especially of adult features only, will not give us the final composition of insect morphology.

It is with this observation in mind I offer this study of the adult skeleton of *Stagmomantis carolina* Joh. I have made tentative identifications and interpretations of structures, based upon the consideration of currently acceptable morphological studies. Whether my identifications and interpretations, especially the latter, will retain their present status will depend upon further study of the Carolina mantis. I have begun this morphological study with the adult skeleton simply because we know more about the adult skeleton than of any of the other insect structures. Again, a knowledge of

the ultimate of such a basic system as the skeleton will aid in interpreting the ontogeny, and the ontogenetic morphology of the Carolina mantis is the goal of my research.

It will be noticed that I have not conformed closely to the use of terms and interpretations more or less generally adopted by the older morphologists. For the past few years I have become more and more certain that entomology is encumbered with many bad terms and interpretations, and fortunately, many can be dismissed readily because they are quite unnecessary. But recently I have presented publicly reasons for my objections to current usage, and since I shall convince no one of the validity of my objections if I conform to such usage, I must apply my convictions to my own research. I hope my aim for simplification and reasonableness does not produce too painful an effect upon the reader, but if it does, I suggest the reader turn to the lists of synonyms, at the end of each part of this paper, and write his preferences over mine.

PART I—THE CRANIUM

EPICRANIUM

All of the skeletal features comprising what is usually called "the head" are features of the cranium. These features are separable into two groups, the epicranial and the gnathocranial. The epicranium includes the prestomal flap (the upper lip) and the morphologically dorsal cuticular areas of the somites fused to form the insect head, whereas the gnathocranium includes the poststomal cranial appendages and the ventral cuticular areas of the postoral cranial somites.

The prestomal flap, or labrum, of the Carolina mantis is well developed, though not strongly sclerotized. It extends from the subfrontal sclerite (Sfr, figures 1 and 14) to the stomal or oral membrane. It has one main sclerite, the labrite (Lbt), a protecting and supporting plate to the inner labral membrane (Lb m, figures 4 and 14). The lower portion of the labral membrane has distinct sensory areas, a velvety median area and two lateral "peg" areas. Above these sensory "pegs" are two V-shaped sclerites, the so-called "tormae."

The remainder of the epicranium, the sclerotized dorsa of the cephalic somites, is strongly developed along the transverse axis, giving the Carolina mantis a somewhat intelligent appearance. The large size of the compound eyes adds to the keen appearance, but these organs contribute more to the predatory effectiveness of the insect than to its psychical abilities. Movements from all directions

can be caught by the eyes, even from the rear, as may be seen from figure 4. The corneas (E) of the compound eyes are separated from the median portion of the epicranium by cuticular infoldings which form the ocular ridges (o r, figure 5).

The major infolding of the epicranium is the submarginal infolding (see figure 3). This feature has not been recognized, heretofore, as a single, essentially continuous inflection, but as a number of separate infoldings; the subfrontal (sfr s, figure 3) or "epistomal," the subgenal (sge s) or "pleurostomal," the suboccipital (soc s) or "hypostomal," and the postoccipital (poc s). The Carolina mantis does not show to best advantage the continuous submarginal nature of these infoldings for the anterior "tentorial" pits are turned up partially and the subgenal infoldings are not evident. If we allow for these special modifications, though, we can see the essential continuity by deriving the diagrammatic figure 3 from the actual specimen shown in figure 5. The continuous nature of this epicranial feature is more obvious in the more generalized of orthopteroids, such as the cricket. I regard the submarginal inflection as a feature of first rank of the insect epicranium. It forms the chief supports and points of articulation.

In addition to the submarginal infolding the Carolina mantis epicranium has the temporal (tms, figure 1) and the occipital (occ s, figure 4) infoldings. The temporals run into the occipital, and since the latter lacks the supraforaminal portion (shown by the dotted line in figure 4) the temporal and occipital infoldings appear to be a bilaterally paired feature rather than two separate features.

All of these infoldings appear as two types of surficial features, externally as lines or "sutures," and internally as ridges. In using the term suture in reference to the epicranium the student should not confuse the external lines of the infoldings with the moulting line, the epicranial suture (eps, figure 1). This suture is a line of cuticular weakness, not the result of a cuticular infolding.

In the Carolina mantis the epicranial suture extends from the occipital sclerite to the lateral ocelli (oc, figure 1). Its arms are not homologous to those of more generalized insects, but are morphologically posterior. In the generalized cranium the stem of the epicranial suture extends forward to the median ocellus, then branches about that organ into the "frontal" sutures, which extend to the anterior "tentorial" pits mesad of the antennal bases.

These sutures, moulting lines and infolding lines, mark off areas of the epicranium. Some students see segmental significance in cer-

tain ones of these areas. I am skeptical of such interpretations for these sclerites are the results of a highly developed secondary condition. The generalized epicranium appears to be a sclerotized product of the fused dorsa of the cephalic somites. Cuticular inflections, with their additional thickening and sclerotization, are features of support of this skull, and are features for the needs peculiar to the functions of the generalized insect skull. From this point of view the search for segmental definitions in the adult epicranium appears to be one entirely for the optimist. To me it seems more reasonable that the epicranial sclerites are more or less persistent areas because the specializations arise from a common fundamental plan. The struts and braces may be altered variously, and consequently alter the sclerites, but they are essentially the same struts and braces.

From this point of view the Carolina mantis epicranium is subdivided into five sets of sclerites, single and paired, by the inflections and moulting line. On either side of the epicranial suture are the epicranial sclerites (Epc, figure 1). Laterad of these are the temporal sclerites (Tmp). Below the arms of the epicranial suture is the frontal sclerite (Frn), and laterad of the frontal area are the genal sclerites (Ge). In the Carolina mantis the preocular and hypocular* portions of the genal sclerites are greatly reduced, whereas the posterior portions (see figure 4) are rather large. The main sclerite of the posterior aspect of the Carolina mantis epicranium is the occipital (Occ).

Some of these sclerites, the frontal, genal, and occipital, are subdivided by the submarginal infolding; thus, from the frontal sclerite is separated the subfrontal (Sfr, figure 1) or "clypeus," from the genal the subgenal (Sge— not definite in this mantid) or "pleurostoma"; from the occipital the suboccipital (Soc, figure 4) or "hypostoma," and the postoccipital (Poc). These terms and interpretations will not be found in textbooks, but they should hardly be dismissed for such a reason. I have approached the interpretation of the Carolina mantis epicranium from a new point of view, and if it is worth while to reinterpret, it is also worth while to correct our terminology. Medical men no longer explain diseases in terms of biles and humors; with new concepts have come new terms.

* The prefixes *sub* and *hypo* have been used interchangeably, as their definitions permit; but, for the sake of clarity I propose we limit *sub* for subdivisions of features, and *hypo* for features ventral in position.

There remains one more structure of the epicranium to discuss, the so-called "tentorium" or "endoskeleton." I am pleased to find that Dr. N. S. R. Maloeuf, of Cornell University, refuses to recognize any "endoskeleton" in insects. Now there are at least two with the same view. However, if we are to clean house we may as well be thorough, and if there is to be no endoskeleton I wish there would be no "tentorium." This structure (see figures 5 and 6) resembles more closely a brace than a tent; consequently, I believe *transtrum,* the Latin for a cross brace, preferable to tentorium.

The transtrum of the Carolina mantis consists of two pairs of invaginations and one pair of weak evaginations. The anterior pair of invaginations forms the anterior transtral arms (At a). Usually these invaginations originate between the subfrontal and subgenal ridges, but in this peculiar insect they are turned up partially. From the anterior arms the weak, flexible dorsal arms (Dt a) arise and extend to the antennal ridges. The posterior portions of the anterior arms are partly fused to form the transtral body (Bd T). This body unites with the posterior invaginations (Pt a), which originate between the suboccipital and postoccipital ridges (see figure 16).

THE CRANIAL APPENDAGES AND GLOTTA

THE ANTENNAE: These appendages of the Carolina mantis are simple and filiform. They consist of three segments, a basal (I of figure 2), an intermediate (II), and a distal (Flgm) which is subdivided into a comparatively large number of subsegments. The appendage is an evagination of the cranial cuticula, and, therefore, is not *inserted* upon the epicranium. The sclerotized cuticula around the antennal base is submarginally infolded, and forms a finger-like process, the antennifer (ant f), upon which the basal antennal segment pivots. The basal membrane permits considerable freedom of movement.

The intermediate segment (II) is a plug-like segment which articulates with two points of the distal rim of the basal segment. No muscles extend from the third segment to the second, but if cleared antennae are examined under the compound microscope it can be seen that there is a very definite demarkation between the second and third segments, and that the "segments" of the flagellum are merely subdivisions of a superficial nature.

THE GNATHAL APPENDAGES: The antennae are preoral appendages, and possibly not fundamentally metameric limbs. The gnathal

appendages are postoral and are unquestionably metameric limbs; what we know of their structure and ontogeny indicates they are fundamentally the limbs of the three postoral cranial somites. For the morphological interpretations of the gnathal appendages I follow Snodgrass' theories.

The anterior gnathal appendages are the mandibles. These appendages of the Carolina mantis are of the generalized orthopteroid type. They are rather conical in form (figures 7, 8, 10), and are heavily sclerotized. Figure 8 illustrates the manner of articulation of the right mandible with the epicranium. The anterior articulatory point is the cup-shaped socket *a*, into which the knob *a'* fits. This knob is a sclerotized thickening of the subfrontal margin. The posterior articulatory point of the mandible is *b*, a rather large knob which fits into the socket *b'*, a feature formed of the suboccipital ridge. About the points of articulation the connecting membranous cuticula is very narrow, not permitting much separation of the points of articulation.

Between the anterior and posterior articulatory points, on the outer surface of the mandible, an infolding produces the internal shelf shown in figure 8, *c*. The purpose of this shelf is not apparent. The extensor muscle is attached to the tendon *et*, a cuticular extension from the membrane just above the sclerotized edge of the mandible. The flexor tendon, *ft*, is an elaborate cuticular extension of the membrane just above the median mandibular margin. The lower portion of this tendon is somewhat sclerotized. Immediately anterior to the base of the flexor tendon is a slender sclerite (3) to which a mandibular muscle is attached. The median end of this sclerite is in contact with the crescenteric sclerite (2) of the "hypopharynx."

From the point of view of function the mesal surface of the mandible is the most interesting. Figure 10 shows the structural features for mastication. Distally, on the right mandible, there are two rigidly sclerotized processes (in p) which function as incisor teeth. These processes are sharp, and if their presence is kept in mind the finding of bits of even carabid beetle plates in the rectum of the mantis is not so astonishing. From the anterior incisor process a knifelike ridge extends halfway up the mandible. At this mid-point the ridge continues across the mesal surface, forming a sharp molar ridge. The Carolina mantis does not chew its victims too finely, and the form of the molar ridge explains this fact.

The mandibles of the Carolina mantis are not bilaterally symmetrical in respect to their masticatory features. The anterior portion

of the molar ridge of the left mandible fits above the same structure of the right mandible, giving the apposition necessary for mastication. In addition, the left mandible has three fully developed incisor processes rather than two.

Posterior to the mandibles are the second gnathal appendages, the maxillae. From figures 9 and 13 it can be seen that the Carolina mantis maxilla is generalized and orthopteroid. The palp (Plp) is simple and five-segmented, with the basal segment in direct contact with the stipes (Stp). This plate is the largest of the appendage. It has a longitudinal inflection which furnishes a ridge (st r, figure 13) for the attachment of a large muscle.

Above the stipes is the cardo (Cd), the functional base of the Carolina mantis maxilla. An inflection (cds) traverses the center of the cardo, forming an internal ridge for muscular attachment and a process (cd p, figure 16) to which is attached the extensor tendon *et* (figure 13). The manner of articulation is shown in figure 16. This is a drawing of the right cardo from an angular view; the labels of the features should orient the reader.

There are no definite basal maxillary articulatory points comparable to those of the mandible. The medial portion of the cardo is distended into a cone-shaped process (d) which is in close contact with the suboccipital sclerite. The connecting membranous cuticula is very narrow at this point of contact, and permits but little separation. Other parts of the connecting membrane are ample, permitting much freedom of movement.

The process of the cardinal inflection (cd p, figure 16) passes beneath the suboccipital sclerite, and to its inner end is attached the extensor tendon. A tug by the extensor muscle will rotate and lift the distal portion of the cardo, and press point *d* against the suboccipital sclerite. The antagonists to the extensor pull against the cardinal and stipital ridges, and in this function, too, point *d* is pressed against the suboccipital sclerite.

In considering the endite lobes of the maxilla I feel again in a revising mood. The "galea" (Plx, figures 9 and 13) is a thumblike endite, yet, galea is Latin for helmet or headpiece. How much more descriptive is the term pollex. "Lacinia" is Latin for the lappet of a garment. It might be we could stretch things a bit for the sake of priority and consider this lobe (Fcp) a lappet. However, it was with some difficulty that I first learned to identify this endite lobe as the "maxillary lacinia." If it had been named the maxillary forceps the

structure and its term would have had a more accurate meaning. I believe that students will find maxillary pollices and forcipes more significant.

The anterior surface of the maxilla (figure 13) is not so interesting, morphologically, as the posterior surface. The mesal margin of the forceps is studded with stout spines and hairs. The pollex has scattered sensory hairs about its distal surface. Near the base of the forceps a stout tendon (ft) extends from the membranous cuticula.

The third postoral appendages of the cranium are partly united to form a lower lip, the labium (figure 12). Figure 14 shows that both the prestomal flap and the labium are appropriately termed lips.

The labium is in close contact with the epicranium at the lower ends of the postoccipital sclerite. There are no definite articulatory points; the points *e* are separated from the postoccipital sclerite by narrow strips of membranous cuticula. At all other points the labium is separated from the remainder of the cranium by relatively large membranous areas.

The points *e* are probably homologous to *d* of the maxillary cardo, but since we are not sure of the large basal labial plate (Mt) it is better to call it the mental sclerite. My use of mentum is different from that of the older students. They called this plate the "submentum," and in insects with this chin-plate divided, they called the subdivision the "mentum," and the main part of the plate "submentum"!

If we cannot assume safely that the mentum is the fused cardines of the labium we can at least be certain of the labial stipital areas (Stp, figure 12). The partly united stipites bear the simple three-segmented palps. The labial stipites of the Carolina mantis have been identified as the mentum.

As in the maxillae the labial stipites each bear two endite lobes. We have admitted of the serial homologies of these lobes in the maxillae and labium, yet we have retained the old terms "glossae" and "paraglossae" for the labial lobes. On the first point, these endite lobes are hardly tongues in either form or function. Then, if these lobes are homologous why not recognize the homologies in our terms? I propose that we strive for simplicity and reasonableness in this complex enough study, and that the labial "glossa" become the labial forceps (Fcp, figure 12) and the "paraglossa" become the labial pollex (Plx).

The labium of the Carolina mantis is not uniformly sclerotized.

This fact may be made apparent by staining.* The basal portion of the mental plate is more heavily sclerotized than the lower or distal. There are two peculiar unpigmented spots (f) in the basal portion. The purpose of these spots is obscure; no muscles are attached to their inner surfaces.

The stipites are not uniformly sclerotized. The median areas, outlined with broken lines in figure 12, and the lateral pieces, are heavier. On the center of the basal margin of the stipites are two triangular areas, which are well sclerotized; they are bases for muscles. There are no sclerites on the anterior surface of the labium (figure 12 shows the posterior surface only).

THE GLOTTA: Between the gnathal appendages lies the venter of the cranium, the so-called "hypopharynx." Some years ago Snodgrass called our attention to the fact that what we formerly considered as pharynx was not pharyngeal, but preoral. In figure 14 the mouth of the Carolina mantis is shown by *Mth.* The space between the labrum, mandibles, and "hypopharynx" is the preoral space (Pr sp). We do not refute this observation of Snodgrass, but, regardless, we keep calling the inner surface of the labrum the "epipharynx," and the tongue-like cranial venter "hypopharynx." Obviously we can do without the former, and we should change the latter. The tongue, for it functions as a tongue in the generalized insect, has been called the lingua, but there is considerable prejudice against that Latin word. Possibly glotta, the Greek for tongue, will prove satisfactory.

The glotta of the Carolina mantis is shown from the anterior surface in figure 11, and from the lateral aspect in relation to the labrum and labium in figure 14. A velvety down of sensory hairs covers most of the anterior surface, which is relatively thick though not strongly sclerotized. The posterior surface is more sclerotized, but is thinner. At the base of the glotta are three pairs of sclerites; *1* is called the "suspensorial bar," *2* is a slender crescent, a base for muscular attachment, and *3* is a loop extending from *2* to the vestigial mandibular adductor.

The salivary glands empty into a common duct (Sl d, figure 14), which leads into a salivary pocket (Sl p, figures 14 and 15), between the glotta and anterior surface of the labium. The saliva flows out of this pocket down the median groove of the posterior glottal sur-

* If the skeleton is cleared of tissues with KOH and rinsed in distilled water, the sclerites can be stained by placing the skeleton in hot iron alum for a few minutes. The stain does not fade perceptibly for some time if the specimens are kept in eighty percent alcohol.

face, and collects in drops at the distal tip of the glotta. Figure 15 shows the details of the salivary pocket from an angular anterior view. The anterior surface is cut and folded over to show its relationship to the posterior wall. The sides of this pocket are supported by the sclerites *5* and *6*.

GENERALIZATIONS

The gnathocranium of the Carolina mantis is conservatively orthopteroid and generalized. The maxillae, mandibles, and glotta differ little from Snodgrass' concepts of the generalized pterygotan forms. The salivary pocket differs from the generalized form in that it is quite large, and the labium is relatively lightly sclerotized.

The epicranium has not retained the primitive form so well. The dorsal-most portion has been greatly elongated transversely, and flattened longitudinally. Temporal ridges have arisen, most probably in response to the strains of the huge mandibular flexor muscles. An odd condition is the union of the temporal and occipital inflections, with the suppression of the supraforaminal portion of the occipital. The subgenal inflections have been suppressed, possible because of the reduced condition below those enormous compound eyes.

SYNONYMIC TERMS FOR THE CRANIUM

New terms	*Older equivalents*
Antennal segment I	scape
Antennal segment II	pedicel
Antennal segment flagellum	remainder of "segments"
Cranium	head, head capsule
Epicranial sclerites	vertex, parietals
Epicranial suture	coronal plus frontal sutures
Epicranium	dorsal part of cranium plus prestomal flap
Forceps	in maxilla = lacinia; in labium = glossa
Glotta	hypopharynx
Gnathocranium	hypopharynx plus gnathal appendages
Labral membrane	epipharynx
Labrite	"labrum"
Labrum	whole of prestomal flap
Mental sclerite	submentum plus mentum
Occipital sclerite	occiput plus postgenae
Pollex	in maxilla =.galea; in labium = paraglossa
Preoral space	mouth cavity, cibarium
Prestomal flap	cuticula of prostomium
Subfrontal infolding	epistomal ridge
Subfrontal sclerite	clypeus
Subgenal infolding	pleurostomal ridge
Subgenal sclerite	pleurostoma, mandibularia
Suboccipital infolding	hypostomal ridge
Suboccipital sclerite	hypostoma
Transtrum	tentorium

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TABLE OF ABBREVIATIONS

A	anterior in direction	Mn	mandible
a á	anterior articulatory points of mandible	m r	molar ridge
		Mt	mental sclerite
antf	antennifer	Mth	mouth
At a	anterior transtral arm	oc	ocellus
at p	anterior transtral pit	Occ	occipital sclerite
b, b′	posterior articulatory points of mandible	oc f	occipital foramen
		occ r	occipital ridge
Bd T	body of transtrum	o r	ocular or corneal ridge
c	inner shelf of mandible	P	posterior
Cd	cardo	Phy	pharynx
cd p	cardinal process	Plx	pollex
cd s	cardinal suture	Poc	postoccipital sclerite
d	basal point of cardo	poc s	postoccipital suture
Dt a	dorsal transtral arm	Pr sp	preoral space
E	cornea of compound eye	Pt a	posterior transtral arm
e	basal point of labium	pt p	posterior transtral pit
Epc	epicranial sclerite	R	right
eps	epicranial suture	Sfr	subfrontal sclerite
et	extensor tendon	sfr s	subfrontal suture
Fcp	forceps	Sge	subgenal sclerite
Flgm	flagellum of antenna	sge s	subgenal suture
Frn	frontal sclerite	Sl d	salivary duct
ft	flexor tendon	Sl p	salivary pocket
Ge	genal sclerite	Soc	suboccipital sclerite
Gl	glotta	soc r	suboccipital ridge
in p	incisor process	soc s	suboccipital suture
L	left	Stp	stipes
Lab	labium	st r	stipital ridge
Lbm	labrum	St s	stipital suture
Lb m	labral membrane	Tmp	temporal sclerite
Ll m	labial membrane	tms	temporal suture

EXPLANATION OF FIGURES

PLATE IX

FIGURE

1. Anterior view of epicranium.
2. Ventral surface of antennal base.
3. Diagram of submarginal inflection, derived from figure 5.
4. Posterior view of epicranium.
5. Angular view of epicranium with upper anterior portion cut off.
6. Dorsal view of transtrum.

PLATE IX

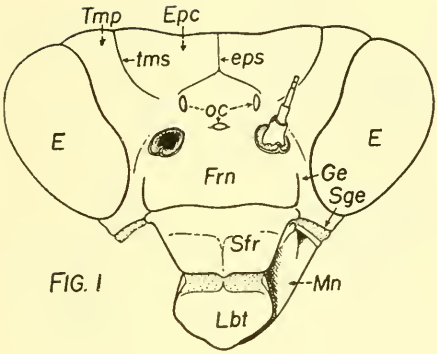

FIG. 1

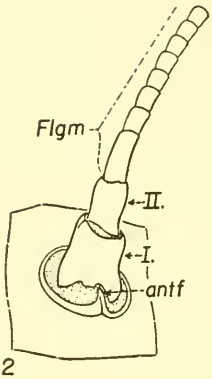

FIG. 2

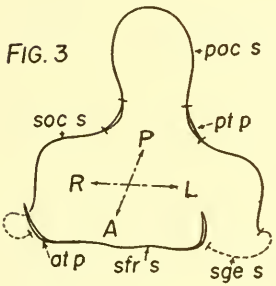

FIG. 3

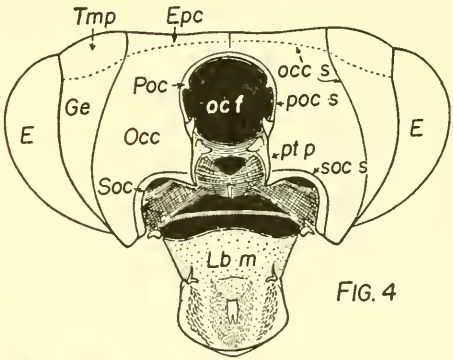

FIG. 4

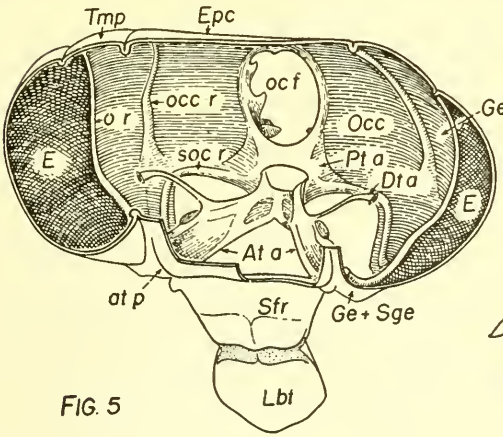

FIG. 5

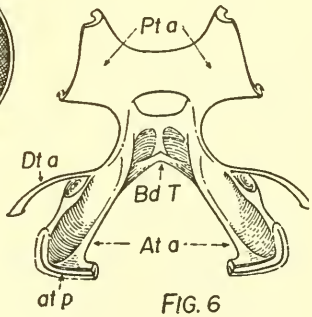

FIG. 6

PLATE X

FIGURE

7. Anterior surface of right mandible.
8. Articulation of mandible with epicranium from mesal plane.
9. Posterior surface of right maxilla.
10. Mesal surface of right mandible.
11. Anterior surface of glotta.
12. Posterior surface of labium.
13. Anterior surface of right maxilla.
14. Lateral surface of glotta, with labrum and labium in section.
15. Angular view of salivary pocket.
16. Articulation of right cardo.

PLATE X

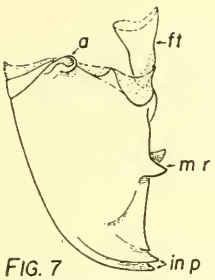

FIG. 7

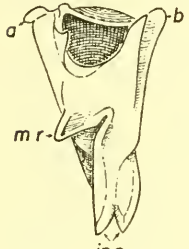

FIG. 10

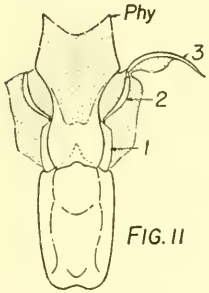

FIG. 11

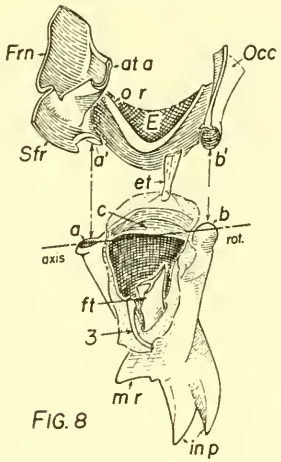

FIG. 8

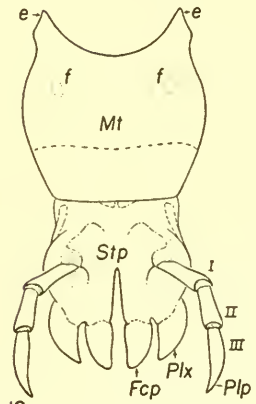

FIG. 12

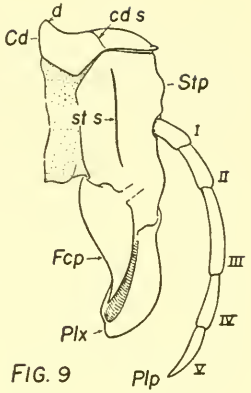

FIG. 9

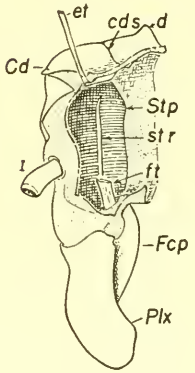

FIG. 13

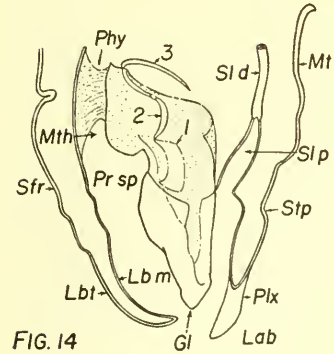

FIG. 14

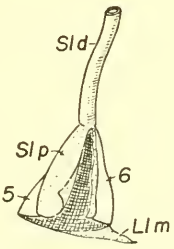

FIG. 15

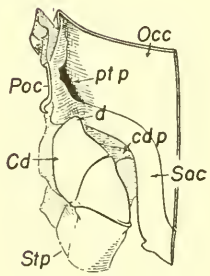

FIG. 16

PART 2—THE THORACIC SKELETON

The Cervical

The neck of the Carolina mantis is an elaborate mechanism interposed between the head and prothorax. It is relatively elaborate because few insects have this body region so highly developed for the movement of the head. The Carolina mantis need not be envious of the mammal for its flexible neck.

Figures 7 and 10 (Plate XI) indicate the external form of this mantid's neck skeleton; figure 7 is a ventral view, and 10 is an angular dorsal view from the left side. An interesting oddity of this neck skeleton is its suspended position. Usually the orthopteroid neck is inserted within the prothorax, but in this insect it lies outside and below the prothorax.

The cervical sclerites are large, and rather numerous. A pair of dorsal sclerites (d Cv, figure 10) intervenes between the postoccipital sclerite of the cranium and the dorsal longitudinal muscles passing through the prothorax. These muscles are attached to the tendons *2*, which are cuticular extensions from the cervical sclerites. Laterad of these sclerites are the lightly sclerotized areas *3*. The function of these areas is not obvious for no muscles are attached to them, and, their degree of sclerotization is too slight for protection to this vulnerable region.

The lateral cervical sclerites (l Cv_1, l Cv_2), the important features from the standpoint of function, are large and well sclerotized plates. The anterior knoblike points of the first lateral cervicals lie adjacent to the indentations of the postoccipital sclerite below the label *Poc* of figure 4, plate IX. These points are the fulcra upon which the cranium nods up and down.

Posterior to the first lateral cervical sclerites are the second lateral cervicals (l Cv_2). These sclerites are folded ventrally and toward each other, instead of being in line with the first lateral cervicals, the generalized condition. Two small sclerites (4), probably parts of the posterior margins of the second lateral cervicals, intervene between the latter and the cervical rim of the prothorax. The dorsal points of these sclerites are adjacent to the juncture of the prothoracic "episterna" and precoxal bridges. Between the lateral cervicals are the riblike ventral cervical sclerites (v Cv_1, v Cv_2, figure 7). These cervicals are well sclerotized, but they are not connected with the musculature.

In his textbook Snodgrass said, "The true morphology of the cervix is still obscure—." This observation should not be disregarded, for nothing is quite so valueless as speculation upon morphological identities from scant anatomical knowledge. I am deferring the consideration of the morphology of the Carolina mantis neck skeleton until I study its embryology.

THE PROTHORACIC

As a general characteristic the Orthoptera have the prothorax rather distinct from the other two thoracic segments, and the mantids are of special interest in this respect, for certain species have this somite extremely elongated. In the Carolina mantis the prothorax is not only a distinct body segment, but because of its length it is also an important functional unit, a lever for this insect's peculiar predatory features.

The skeleton of the Carolina mantis prothorax is formed mostly of the tergum and sternum (see figure 1, plate XI). The pleural structures contribute to the coxal and supracoxal regions, but they are in a reduced condition in contrast to the greatly elongated tergum and sternum. Such a long cuticular unit needs strengthening features, especially if it is to be subjected to the actions of the neck, foreleg and posterior prothoracic muscles of the Carolina mantis. These strengthening features are in the tergum.

This sclerotic plate, the tergum, forms a hemicylindrical arch over the relatively flat sternum. In addition to the intrinsic transverse strength of this form, a transverse cuticular infolding (1 of figure 2) braces the tergal arch against the strains of the large foreleg muscles. The hemicylindrical arch has also an intrinsic longitudinal rigidity, but this intrinsic resistance is intensified by three features, a median carina and the two peculiarly folded lateral edges of the tergum. The median carina is postcoxal in position. It is sharply folded, thickened, and well sclerotized. The lateral tergal edges function as V-shaped longitudinal beams.

The sternum is extensively fused to the arching tergum, particularly in the postcoxal region of the prothorax. In the precoxal portion the pleural sclerites intervene between the sternum and tergum. Figure 6 shows the relationship of tergum, pleurites, and sternum in the precoxal region, in transverse aspect. From the posterior edges of figures 2 and 3 the relationship of tergum to sternum in the postcoxal region may be seen.

The sternites of the generalized pterygotan thoracic sternum are well developed in the prothoracic sternum of the Carolina mantis, though they are not sharply demarked. The anterior-most, the basisternite (Bst, figures 1, 3, 4), is long and relatively narrow. It is separable from the precoxal portions of the pleura only by slight cuticular inflections (shown by broken lines in figure 3). The posterior margin of the basisternite is continuous with the "episterna."

Between the coxae is a splinterlike sclerite, which may be part of the basisternite, or of the furcasternite. Possibly the study of the development of the Carolina mantis will indicate the identity, but for the present time this identity is of little importance. The important feature of this sternum is the elongated furcasternite (Fst, figure 1), the sternite which contributes most to the ventral surface of the prothorax. This sclerite of the Carolina mantis has been identified as the spinasternite, but from figure 4 it can be seen that the furcal invaginations (f a) arise within the anterior margin of this sclerite. Posterior to these invaginations the furcasternite is definitely a single sclerite to the points of the separation of the tergum from the sternum (see figure 1). At these points of separation there are two peculiar notches in the edges of the sternum (5, figure 9).

In the African Cameroon mantid *Theopompella heterochroa* Gerst., the sternum, at points similar to those of the Carolina mantis, is deeply notched. In addition, in the Cameroon mantid, there is a definite line between the notches, about which the selerotization is weaker than in either the furcasternite or spinasternite. I regard this condition as intermediate between the fused condition of the Carolina mantis, and the primitive state in which these sclerites were separate.

Posterior to the furcasternite is the spinasternite (Spst, figures 1, 9). Fundamentally the spinasternite is a ventral intersegmental element. In the case of the Carolina mantis it seems that a portion of the prothoracic sternum proper has become sclerotized and continuous with the intersegmental element. This element is restricted, most probably, to the area about the spinal process (Sp p, figure 9).

The pleura of the prothorax are peculiarly modified and overlapped, but they are essentially modifications of the generalized pterygotan thoracic pleurum. However, before considering the modifications of this mantid's prothoracic pleura, my definition and interpretation of the generalized pleurum should be made clear. First, I prefer to Latinize the Greek *pleuron,* for Greek diminutives are not so easily adapted to our terminology. On the second point,

I prefer to think of the pleurum as the sclerotizations between the tergum and sternum, not as the whole side or lateral wall of the thoracic segment.

The lateral wall of the thoracic segment of pterygotans is braced by two ribs. As to the origins of these ribs I favor Snodgrass' subcoxal theory. This theory appears overelaborate at first glance, but if the student study the fundamental morphology of the insect abdomen the subcoxal origin of pleurites becomes a most plausible one.

The basal subdivision of the primary coxa is the pleural arch of the adult pterygotan, the important support of the thoracic lateral wall. The second subdivision is the pleurellar, or "trochantinal" arch. These two subdivisions are not separate plates in the mature pterygotan, but are partially fused to form the functional thoracic pleurum. In most Orthoptera an anterior portion of the pleurellar arch remains relatively independent of the pleural arch. This independent sclerite is called the "trochantin," a term of doubtful significance in this case. Since it is a part of the pleurellum, I think it should be called the pleurellite.

The united pleurellum and pleural arch are infolded dorsoventrally. This infolding is usually thickened and strongly sclerotized to form the brace between tergum and sternum. It divides the pleural arch into an anterior prepleurite ("episternum") and a posterior postpleurite ("epimeron"). Often the ventral portion of the prepleurite is separated off, and termed the precoxal bridge, or "latero-sternite."

The prothoracic pleurum of the Carolina mantis is an odd modification of this basic plan. The prepleurite (Prpl, figures 2, 4, 5, 8) is relatively well developed, though by no means comparably to the tergum or sternum. It extends from the pleural infolding (pl r, figure 8) to the cervical rim of the prothorax. Its lower, or ventral, portion is marked off by slight inflections as a precoxal bridge (Prc b).

The postpleurite is not readily identified in this segment. From figure 4 we can see that this pleurite (Pspl) which is generally posterior to the pleural infolding, is, in the Carolina mantis, reflected forward over the prepleurite. However, as shown in figure 5, the postpleurite is reduced, and not clearly demarked from the tergum.

In this mantid's prothorax the pleurellar arch is remarkably developed. It is an important part of the functional pleurum, as may be seen from figures 5 and 8. In figure 5 the anterior portion of the

pleurellum (Pll) is shown detached from the prepleurite. A better idea of the relationship of the pleurellum to the pleural arch may be gained from figure 8. The line labeled *6* is the line of separation of the two pleural plates. It continues across the pleural apophysis (pl a), and if the lower part is pulled away from the upper portion of the pleurum, the longer part of the pleural apophysis remains with the pleurellum, leaving the pleurum as on the right side of the specimen drawn in figure 3.

The anterior portion of the prothoracic pleurellum is divided into two pieces, a basal piece which is in close contact with the prepleurite, comparable to the ventral portions of the pterothoracic prepleurites proper (not the precoxal bridges), and a distal piece, the movable pleurellite. The tip of this pleurellite forms an accessory coxal articulatory point.

The main coxal articulatory point is the knobbed ventral tip of the pleural ridge (cxf, figures 5 and 8). Posterior to the pleural infolding the pleurellum is oddly folded and distorted. It is divided into two sclerites, the knobbed *7* of figure 8, and the folded *8*. The latter sclerite is a base for muscular attachment. Usually this part of the pleurellum is fused to the postpleurite, and, the condition of the Carolina mantis is appropriately labeled peculiar.

In addition to the peculiar modifications of the pleurites themselves, the prothoracic pleura of the Carolina mantis are overlapped by the precoxal portion of the tergum. Figure 6 is a transverse section of the precoxal region, illustrating the relative development of tergum, pleura, and sternum.

THE PTEROTHORACIC

The mesothoracic and metathoracic segments of the Carolina mantis form a body unit, the pterothorax. It is a unit as distinct as the prothorax, and one as important, for it is the locomotor center of this insect's body. The prothoracic legs are so modified for grasping they are of little use for walking. This function is left to the pterothoracic legs. These two pairs of legs are practically the sole means of locomotion of this insect, since the wings and their associated structures are hardly adequate for effective flight, especially those of the female.

Although the pterothoracic segments are strongly modified to form a running mechanism, the basic plan of the skeleton is essentially that of the properly functioning, generalized pterothorax. The terga (figures 12 and 15) are large, relatively well-sclerotized plates.

Their anterior portions are crossed by the dorsal intersegmental infoldings. Externally these infoldings are indicated by the sutures *isg s* of figure 12, and internally by the ridges *isg r* of figure 15.

Anterior to these intersegmental inflections of the terga are the pretergites (Prt). Though these sclerites are integral parts of the pterothoracic terga they are not of the same somite origin as the terga with which they are associated, but of the preceding somites. The pretergite of the mesothoracic tergum is a part of the prothorax.* In the Carolina mantis the pretergite of the mesothoracic tergum is a single sclerite, and an odd one. The lateral edges are submarginally infolded, and from the anterior ends of these infoldings two stoutly sclerotized, tubular invaginations (1 of figures 12 and 15) extend into the body cavity. The pretergite of the metathoracic tergum is not single, but of four pieces. The posterior-most piece forms a border to the tergum. Its lateral edges are not infolded, and the cup-shaped processes *2* (figure 15) are the counterparts of the tubular processes of the mesothoracic pretergite. Anterior to the border of the metathoracic tergum are the other three pretergal sclerites in the intertergal membrane (figure 15).

The posterior margins of the pterothoracic terga of this mantid are demarked from the central shields by slight inflections. These sclerites, the posttergites (Pst), are folded, the morphologically posterior margins lying beneath the inflections. This manner of folding forms protecting plates to the intertergal membranes.

The shield-shaped portion of each tergum is crossed by two V-shaped inflections. The anterior inflection of the mesothoracic tergum forms a pair of short ridges (ats r, figure 15), and the posterior inflection a pair of long, closely approximated ridges (pss r). These two pairs of ridges are struts supporting the tergum longitudinally. They do not make the tergum absolutely rigid, for there is a line of flexure between them. This flexure is a part of the flexing line of the tergum, a line between the two-wing fulera. The metathoracic tergum has the same inflections as the mesothoracic, though they are not so strongly developed.

The surface areas of the terga these inflections mark off are used frequently by taxonomists for characters. The taxonomists have a set of terms for these areas, which, no doubt, will prove to be persistent names, but which nevertheless are not suitable from the morphologist's point of view. A part of a tergum is a tergite, so "prescu-

* For more details of this condition the reader should study Chapter IV of Snodgrass' "Principles of Insect Morphology."

tum," "scutum," and "scutellum" hardly fit into our interpretations and terminology.

The pterothoracic terga are structurally adequate for flight, but the pleura are not; they are better suited for the running type of insect. These two pairs of lateral supports are poorly consolidated in the Carolina mantis, for nearly half of the lateral pterothoracic walls are membranous. In addition to this poor degree of consolidation, the dorsal portions of the pleura are inclined anteriorly.

The pleural infoldings form the ridges *pl r* (figure 14), the braces separating the terga and sterna. The lower portions of these infoldings are extended into large flat apophyses (pl a). These projections are in close contact with the furcal apophyses (f a, figure 16). The ventral-most points of the pleural infoldings are knobbed to form the main coxal articulatory points (cxf, figure 14); and, the dorsal-most points form the wing fulcra, the alifers (alf).

Anterior to the pleural infoldings are the prepleurites (Prpl, figures 11 and 14), the largest pleurites of this insect. The anterior ventral portions of these pterothoracic sclerites are not separated definitely as precoxal bridges (Pre b) as in the prothorax. From each pterothoracic prepleurite are separated two epipleurites (1 Ep, 2 Ep). Posterior to the pleural infoldings are the long, narrow postpleurites (Pspl). From each of these pleurites one epipleurite (3 Ep) is separated. Of the pleurellum only the movable pleurellite (Plt) is distinct from the functional pleurum. Points 3 and 4 (figures 11 and 14) of the pleurellites are accessory coxal articulatory points.

In contrast to the pleura the pterothoracic sterna are relatively well consolidated though they do permit lateral flexure at the intersternal region. If their posterior portions are disregarded, the form of these sterna is rather suggestive. The basisternites (Bst) are shields not only in function, but decidedly so in shape. As indicated in figure 14, the anterior border of the mesothoracic basisternite is folded back, forming a protection for the preceding intersternal membrane. An interesting feature of the mesothoracic basisternite is the V-shaped inflection (5, figures 13 and 16). This inflection gives the sternite a rigidity not possible from the degree of sclerotization alone. In the metathoracic basisternite a vaguely V-shaped carina (6) corresponds in function to the mesothoracic sternal inflection.

Posterior to the basisternites are the furcasternites (Fst). In the mesothoracic sternum the furcasternite is a continuation of the basi-

sternital inflection. It forms a semicircular arch, through the sagittal plane, between the pterothoracic sternal shields. At the apex of the arch a pair of invaginations forms two stout processes, the furcal apophyses (f a, figure 16). Posterior to these apophyses the furcasternite is flattened, and terminates with its spadelike margin in close contact with the metathoracic sternum. The furcasternite of the metathoracic sternum is similar to that of the mesothoracic in form, but differs in the greater development of its anterior portion and in the reduction of its posterior portion.

Of the thoracic ventral intersegmental elements there are two well developed spinal processes in the Carolina mantis, and possibly there is a vestigial third. The anterior spinal process has been discussed in the section on the prothorax. The posterior spinal process (Sp p of figure 16) is fused to the anterior border of the metathoracic basisternite. It is usually claimed that no intersegmental sclerite occurs between the metathoracic and first abdominal sterna, but, in the Carolina mantis a suspicious looking, bullbous sclerite lies just posterior to the metathoracic furcasternite. It may be merely a part of the furcasternite, but the temptation to call it a vestigial ventral intersegmental sclerite is a strong one. Possibly the study of the development of this insect will furnish something more substantial than a temptation.

THE APPENDICULAR

The wings are relatively large, but they are not well modified for effective flight structures, especially those of the female. The male's wings are long and have sufficient surface to maintain his slender body in the air, though he is capable of only a fluttering manner of flight, but the female's wings are relatively shorter than the male's in spite of her heavier body.

As in all winged Orthoptera, the mesothoracic wings of the Carolina mantis differ from the metathoracic in that they are narrower and more sclerotized. Figure 18 represents the right forewing from its dorsal surface. The costa (C) extends along the entire anterior margin, forming a stiff rib for this margin. Subcosta (Sc) is usually unbranched in the Carolina mantis, though some forewings have an irregularly branched subcosta. Radius (R) is a strongly sclerotized vein, usually two-branched, but often subradius (the "radial sector") is irregularly branched. Medius (M) is weakly sclerotized at its base, but distally it is better developed. Its anterior branch is as often dichotomously branched as it is simple; as a matter of

observation, an individual may have one wing with M_{1+2} as a single piece, and the other M_1 and M_2 separated. The first "cubitus" (1 Cu) branches closely to its base, with the anterior section (1 Cu_a) branching dichotomously twice more. The second "cubitus" (2 Cu) is a single vein, which is sometimes fused with 1 Cu_b, and sometimes terminates without fusing, but it rarely touches the margin. The vannal veins (1V, 2V, 3V) have a common base which articulates with the vannal axillary. Most of the specimens examined had only three vannals, but occasionally a weak fourth vein may be seen. In the wing region between the vannal area and the tergum, the jugal region (Ju r), are usually four weak veins.

The forewings fold back and cover the hind wings, overlapping each other but slightly. Beneath the protecting forewings lie the flexible, fanlike metathoracic wings. These appendages do not overlap each other, but lie side by side, folding first in the region between 1 Cu_b and 2 Cu, and beneath these remigial areas lie the vannal areas folded in the manner of plaited fans.

The longitudinal veins of the metathoracic wing differ from their counterparts of the forewings (see figure 19) in that medius is unbranched, there are usually nine vannals, with the first vannal (1V) many branched, and with the jugal region much reduced. In both pairs of wings numerous cross veins, some X-shaped, some Y-shaped, but most of them simple, intervene between the longitudinal veins.

A close study of the wing bases is essential to an accurate interpretation of the venation, for there is a definite relationship, at least in the more generalized insects, between the longitudinal veins and the wing-base sclerites, the axillaries. Because of this general relationship a change in the specific naming of the axillaries is here proposed:

Proposed terms	Snodgrass' terms	Crampton's terms
Subcostal axillary	1st axillary	Notale
Radial axillary	2d axillary	Proximediale
Medial axillaries	Median plates	Intermediale
		Distimediale
Vannal axillary	3d axillary	Basanale
———	4th axillary	Adanale

The subcostal axillary is generally in close contact with the dorsal base of the subcostal vein, the radial axillary with the dorsal base of the radius, the medial axillaries, though variable, are in close contact with the medius or cubitus, or both, whereas the vannal axillary articulates with the bases of at least the anterior vannal

veins. The fourth axillary, or adanale, is not often present, and when it is present it is obviously a secondary constriction of the tergal edge. This general relationship is not a new observation, so the proposed changes of names should not appear too radical, and they may be beneficial to the elementary student.

Apparently every generalization must have its exceptions, and in this instance the mesothoracic subcostal axillary (Sc ax, figure 17) articulates with the base of radius instead of the subcostal base. This part of the Carolina mantis has been rather modified, for the subcostal base is detached from the subcosta and has fused with the radial base (R b). However, the identity of the subcostal axillary can be affirmed in spite of the modification by its position as intermediary between the tergum and the radial axillary (R ax). The latter sclerite can always be identified, since it rests upon the alifer of the pleurum and is usually in close contact with the radial base.

In the mesothorax the subcostal base (Sc b), the medial axillaries (M ax), and the dorsal sclerite of the radial axillary are all continuous with the radial base, separable from one another only by slight inflections. The vannal axillary (V ax) is continuous with the posterior medial axillary, though it is strongly deflected from the surface level of the medial axillary. In the metathorax (see figure 24) the condition of the subcostal and vannal axillaries is more generalized than that of their counterparts in the mesothorax, but the subcostal base has merged with the radial base, with which the dorsal sclerite of the radial axillary and the medial axillaries are also continuous. From the posterior medial axillary a prong extends into the otherwise separated vannal axillary.

It should be remembered that there are two cuticular surfaces close together at the wing base, the dorsal surface (dwm, figures 20 and 24), which is a lateral extension of the thoracic dorsum; and the ventral surface (vwm), an extension of the dorsolateral thoracic wall. The "tegula" (tg), the subcostal and medial axillaries, and the vein bases are distinctly sclerotizations of the dorsal surface. The other sclerites are more or less closely associated with sclerites of the ventral surface. In figure 20, the ventral surface of the mesothoracic wing base, the subcostal has a ventral base (Sc b). A smaller sclerite lies basad of this subcostal base. Of more significance, however, is the ventral sclerite of the radial axillary. This axillary is a compound sclerotization, for in cross-section it can be seen that the dorsal and ventral sclerites of the axillary are partially fused. Internally the prong of the ventral sclerite is

thickened, and shaped like the engineer's bearing cap, and fits over the alifer of the pleurum. The vannal axillary also has a ventral sclerite, though it does not fuse with the dorsal part.

For locomotion and the procuring of food the Carolina mantis depends almost entirely upon its legs. For the procuring of food the prothoracic legs are more effective than are the pterothoracic for locomotion. The mantis is an awkward insect at any gait.

The pterothoracic legs, however, are the more generalized (see figure 27). The coxa (Cx) of these legs is more or less conical in form. It has a basal infolding (bcr figure 29) to reinforce the basal rim. Two points on the anterior portion of this basal rim are especially thickened for articulation; point *a* (figure 29) is the chief articulatory point which abuts against the coxifer of the pleural infolding, and point *b* is the accessory point which is adjacent to the tip of the pleurellite.

The two articulations, the primary and accessory, differ structurally. Figure 21 is a semidiagrammatic representation of the primary articulation. To the left of the figure is external to the skeleton, and to the right is internal. The Y-shaped piece is the coxifer (cxf) in section, and the folded piece below the coxifer is the basal rim of the prothoracic coxa, in section. The intervening membrane is labelled *m*. From this drawing it may be seen that the thickened point of the basal rim abuts against the coxifer externally. The accessory articulation is more simple. The tip of the pleurellite and point *b* (figure 29) are in close contact, separated only by a narrow strip of thickened membranous cuticula.

Distally the coxa articulates with the base of the femorella (the "trochanter"), at two points. Structurally these articulations are different from the pleuro-coxal. From the disticoxal rim two sclerotized prongs point inwardly at right angles to the coxal wall, and lie adjacently to two sclerotized prongs of the basifemorellar rim which point outwardly at right angles to the femorellar wall, so that with the slender strips of the intervening membranous cuticula, simple hinges are formed. It should be noted that these points are at right angles to the pleuro-coxal points.

The femorella (Fml: "trochanter" is the only misfit in the terminology of the insect leg, and it can be discarded easily) is a small segment functioning as a plumber's "elbow-joint" for the Carolina mantis leg. It is very closely joined to the femur, thereby prevented from moving appreciably upon the femur, but oddly enough there

are rudimentary articulatory points of the prong-hinge type between the two segments, and these points are at right angles to the coxofemorellar articulations.

The pterothoracic femur (Fm) is a long slender tube, articulated to the tibia (Tb) by two prong-hinges. To the tibia the tarsus (Tar) is articulated by a single point. The tarsus is rather generalized, being subdivided into five distinct tarsal subsegments (I-V). The sixth subdivision is represented by the claws (cl) and the unguitractor mechanism (figures 22 and 25). The pulvillus is not present in the Carolina mantis tarsus.

The prothoracic legs differ strikingly from the pterothoracic (see figure 23). They move parallel to the sagittal plane rather than at an angle to it, as do the pterothoracic legs. The coxa (Cx) is greatly elongated and cylindrical in form. Three more or less serrated carinae strengthen this long cylinder. The coxofemorellar articulations of the prothoracic legs are in the same plane as the pleuro-coxal, an odd condition. Ordinarily these two sets of articulations are at right angles to each other.

The femorella (Fml) is rather large, no doubt necessarily, for the femur (Fm) is a very large leg segment. Both femur and tibia (Tb) are studded with strongly sclerotized spines. Whatever prey is not daunted by these spines is effectively held by the hornlike elongation of the distal portion of the tibia. The tarsus of these legs has remained rather generalized. Its long slender form dangling from such a highly modified leg appears, to say the least, incongruous.

GENERALIZATIONS

The thoracic skeleton of the Carolina mantis is the most highly modified part of its body. Two striking modifications characterize this skeletal region, one which might be called a predatory modification, and the other, less obvious but very fundamental, a modification of the generalized plan into a running type of thoracic mechanism. This latter modification is evident in the pterothoracic segments, especially in the form of the pleura. These supporting ribs are reduced, poorly consolidated, and inclined anteriorly. It is not necessary to be familiar with the pterothoracic musculature to surmise that the pterothoracic skelton functions only as a base for the legs of these segments, though, if the ungainliness of the Carolina mantis is considered, it seems that such a strong modification should produce better results.

The pterothoracic appendages are rather generalized. The legs are very simple and slender, and it may be that the slender form of the femora is a negative factor in the development of speed in this insect. Though very generalized, the pterothoracic legs have not retained the puvillus of the tarsus. The wings are typically orthopteran, the forewings being more sclerotized than the hind wings, and the latter being large, fanlike structures. Another orthopteran characteristic of these wings is the great degree of individual variation in the venation. For all practical purposes the wings of the Carolina mantis are merely accessory appendages, inherited but of little value. The insect depends upon its four slender pterothoracic legs for locomotion.

The most interesting modification of the Carolina mantis is the predatory modification, the elongation of the prothoracic skeleton, and the efficient-looking, grasping forelegs. The tergum and sternum are greatly elongated and fused together. The pleura are greatly reduced and overlapped and are, functionally, but minor parts of the skeletal unit. I call this modification a predatory one, for it has changed a generally modest body segment into a long lever which permits full play to those grasping legs. In connection with this predatory modification, the complex neck structures of this mantid should not be overlooked. The neck permits the Carolina mantis to move its head as freely as can most mammals. Such a flexible mechanism increases the predatory effectiveness of those sharp, tearing mandibles.

The best-known characteristic of the mantid is the peculiar form of the prothoracic legs. These legs are held in a prayerful attitude; however, if popular observation were not so superficial, and the sharp look of the mantid's face noticed, the insect would have been named, originally, less deceptively the preying mantis. These prothoracic legs are so highly modified for the grasping function they are quite useless for other functions. They move parallel to the sagittal plane, rather than at an angle to the plane. The tibial, femoral, and coxal articulations are all strongly developed, indicating something of the strength of these legs. An odd and interesting specialization is the hornlike extension of the tibia, a process which prevents even the most armored victim from squirming free of the vice formed by the tibia and femur.

SYNONYMIC TERMS FOR THE THORACIC SKELETON

New terms	*Older equivalents*
Alifer	pleural wing process
Anterior scutal infolding	prescutal infolding
Dorsal intersegmental infolding	antecostal infolding
Epipleurites: 1 Ep, 2 Ep.	basalares (of episternum)
3 Ep	subalare (of epimeron)
Femorella	trochanter
Furcal apophysis	furcal arm
Jugal region	posterior part of anal wing region
Lateral wall (of segment)	pleuron
Medius	media
Pleural apophysis	pleural arm
Pleurellite	trochantin
Pleurellum	trochantinal arch
Pleurite	a sclerite of pleuron
Pleurum	trochantinal plus pleural arches
Posterior scutal infolding	scutellar infolding
Postpleurite	epimeron
Posttergite	posterior reduplication
Prepleurite	episternum
Pretergite	acrotergite, precosta
Sternum	all of ventral sclerotization
Subradius	radial sector
Tarsal subsegment	tarsal segment
Tergum	notum
Vannal (vein)	anal

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TABLE OF ABBREVIATIONS

a ..... main coxal articulatory point
alf ..... alifer
ats r ..... anterior-scutal ridge
ats s ..... anterior-scutal suture
b ..... accessory coxal articulatary point
bc r ..... basicoxal ridge
Bst ..... basisternite
C ..... costa
C b ..... costal base
Cer f ..... cervical foramen
cl ..... claws
Cx ..... coxa
cx f ..... coxal foramen
cxf ..... coxifer
d Cv ..... dorsal cervical sclerite
dwn ..... dorsal wing membrane
f a ..... furcal apophysis
Fm ..... femur
Fml ..... femorella
Fst ..... furcasternite
isg r ..... intersegmental ridge
isg s..... intersegmental suture
Ju r ..... jugal region
l Cv$_1$--Cv$_2$.. lateral cervical sclerite
M ..... medius
m ..... membrane
M ax ..... medial axillary
Pl ..... pleurum
pl a ..... pleural apophysis
Pll ..... pleurellum
pl r ..... pleural ridge
pl s ..... pleural suture
Plt ..... pleurellite
Prc b ..... precoxal bridge
Prpl ..... prepleurite
Prt ..... pretergite
Pspl ..... postpleurite
pss r ..... posterior-scutal ridge
pss s ..... posterior-scutal suture
Pst ..... posttergite
R ..... radius
R ax ..... radial axillary
R b ..... radial base
Rs ..... subradius
Sc ..... subcosta
Sc ax ..... subcostal axillary
Sc b ..... subcostal base
Sp p ..... spinal process
Spr ..... spiracle
Spst ..... spinasternite
St ..... sternum
T ..... tergum
Tar ..... tarsus
Tb ..... tibia
tg ..... "tegula"
tg r ..... tergal ridge
ugt ..... unguitractor
V ax ..... vannal axillary
v Cv$_1$—Cv$_2$. ventral cervical sclerite
vwm ... ventral wing membrane
1 Ab St .... first abdominal sternum
1 Cu, 2 Cu .. first and second "cubitus"
1 Ep, 2 Ep.. epipleurites of prepleurite
3 Ep ..... epipleurite of postpleurite
1V, 2V, etc., vannal veins

PLATE XI

FIGURE

1. Angular lateral view of prothoracic skeleton.
2. Inner surfaces of pleura and tergum in supracoxal region.
3. External surface of anterior portion of sternum.
4. Inner surfaces of pleura and anterior portion of sternum.
5. Outer surfaces of left pleurum, shown outstretched.
6. Transverse section of precoxal region.
7. Ventral view of neck.
8. Inner surfaces of right pleurum and tergum.
9. Inner surface of posterior portion of sternum.
10. Angular dorsal view of neck.

PLATE XI

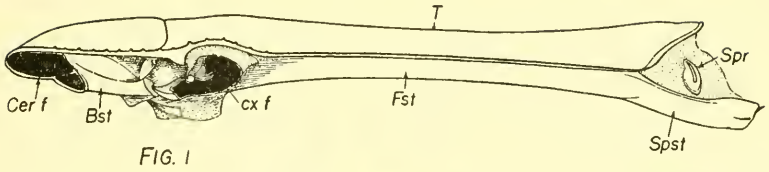


FIG. 1

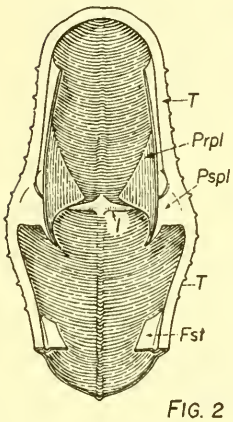


FIG. 2

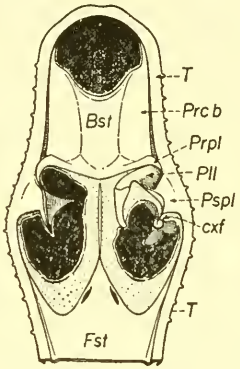
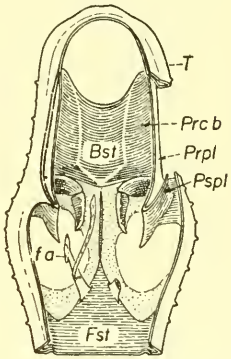


FIG. 3



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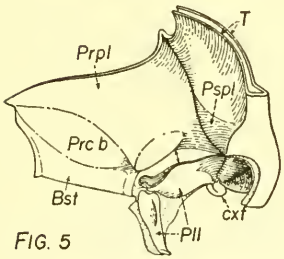
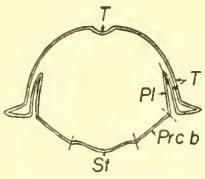


FIG. 5



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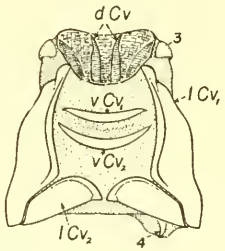


FIG. 7

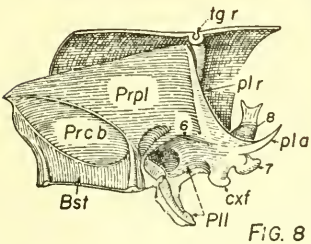


FIG. 8

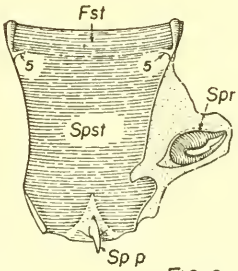


FIG. 9

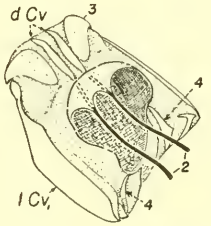


FIG. 10

PLATE XII

FIGURE

11. Outer surfaces of mesothoracic and metathoracic pleura.
12. Outer surfaces of mesothoracic and metathoracic terga.
13. Outer surfaces of mesothoracic and metathoracic sterna.

PLATE XII

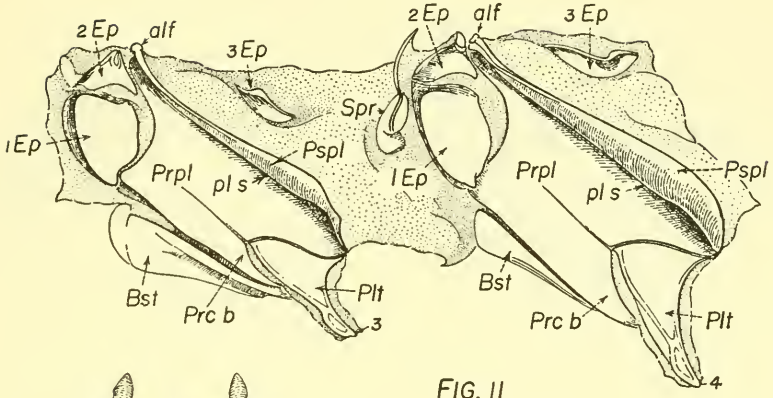


FIG. 11

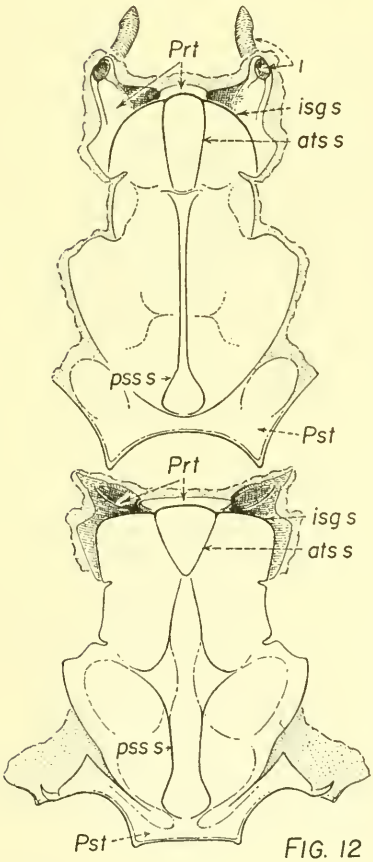


FIG. 12

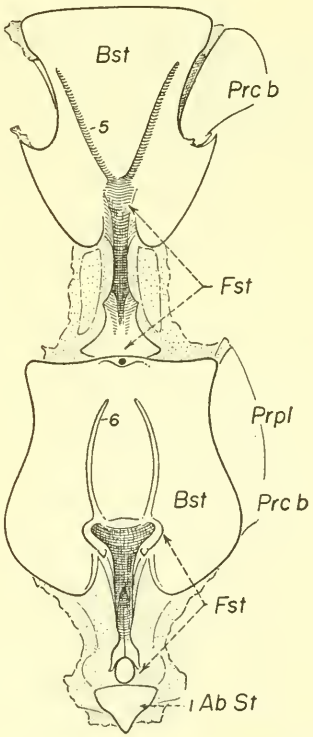


FIG. 13

PLATE XIII

FIGURE

14. Inner surfaces of mesothoracic and metathoracic pleura.
15. Inner surfaces of mesothoracic and metathoracic terga.
16. Inner surfaces of mesothoracic and metathoracic sterna.

PLATE XIII

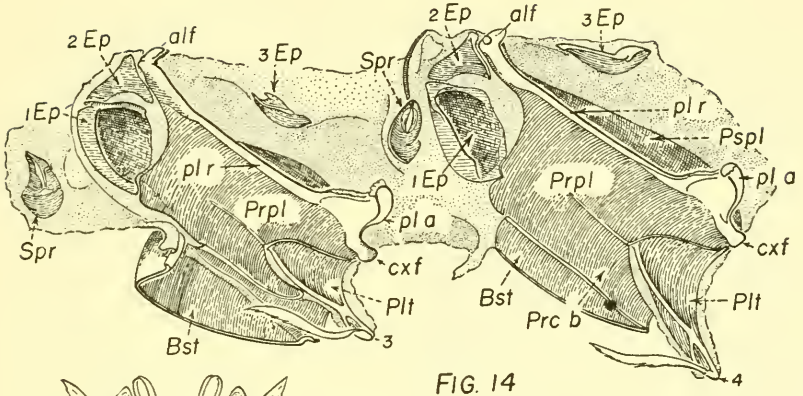


FIG. 14

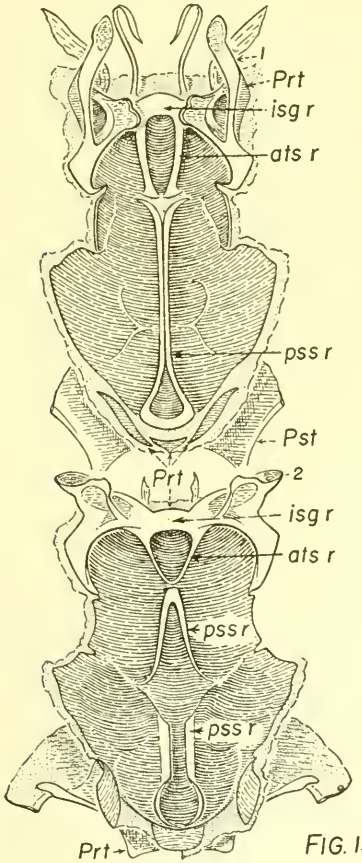


FIG. 15

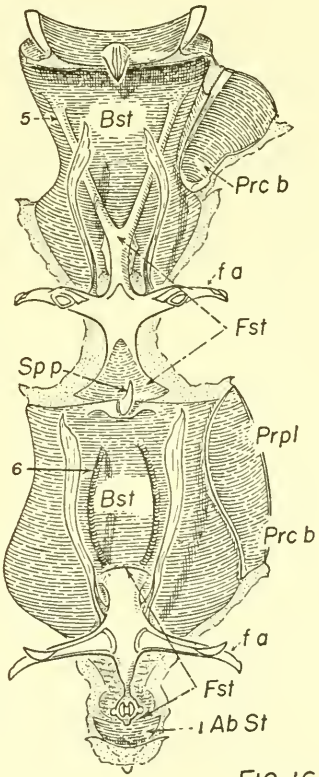


FIG. 16

PLATE XIV

FIGURE

17. Dorsal view of right forewing base.
18. Dorsal surface of right forewing.
19. Dorsal surface of right hind wing.
20. Ventral view of right forewing base.
21. Section through main articulation of prothoracic coxa and pleurum.
22. Dorsal surface of tip of tarsus.
23. Lateral view of left prothoracic leg.
24. Dorsal view of right hind wing base.
25. Ventral view of tip of tarsus.
26. Ventral view of right hind wing base.
27. Anterolateral view of left middle leg.
28. Inner basal structure of left foreleg.
29. Inner basal structure of right middle leg.

PLATE XIV

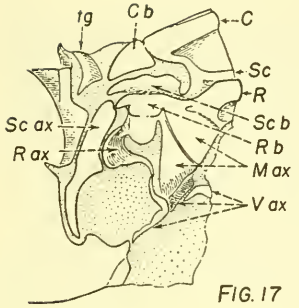


FIG. 17

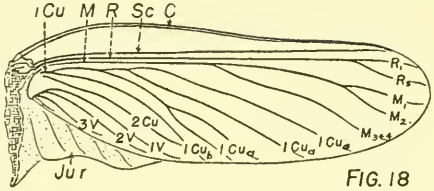


FIG. 18

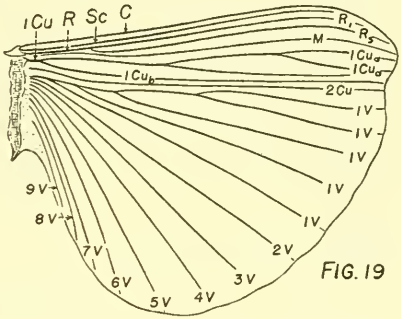


FIG. 19

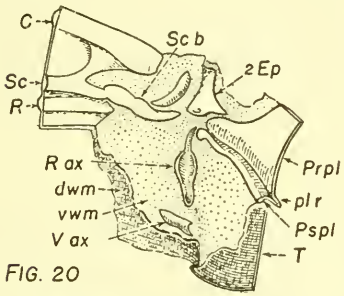


FIG. 20

FIG. 21

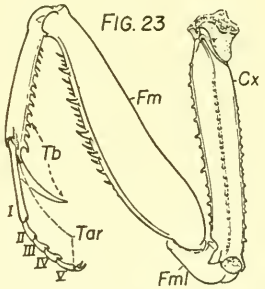


FIG. 23

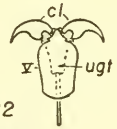


FIG. 22

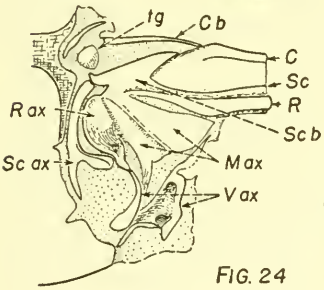


FIG. 24

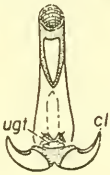
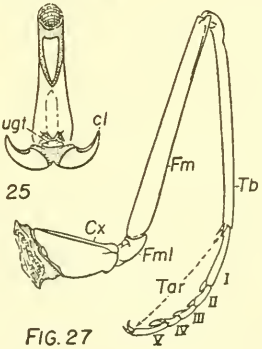


FIG. 25



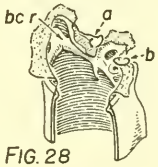


FIG. 28

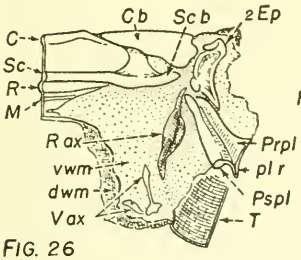


FIG. 26

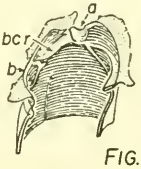


FIG. 29

FIG. 27

PART 3—THE ABDOMINAL SKELETON

In the discussion of the thorax I made the statement that if the morphology of the insect abdomen is understood, the subcoxal origin of the pleurites appears to be a plausible theory of origin. Not only the probable origin of the pleurites becomes apprehensible through an understanding of the morphology of the insect abdomen, but the fundamental plan of the sclerotization and metamerism of the entire insect trunk becomes evident. It was after his studies of insect abdomens that Snodgrass perceived most clearly the fundamental plan of the insect skeleton. Every teacher of entomology should read the first seven pages of his "Morphology of the Insect Abdomen; Part II. The Genital Ducts and the Ovipositor."* These few pages will do more to unsettle the antediluvian concepts of insect structure still prevalent, in spite of Crampton's and Snodgrass' researches of the past twenty years, than any amount of analysis and criticism from a younger student.

PREGENITAL

It is in studying the abdomen that it becomes evident the skeleton of an insect somite has two primary sclerotizations, a tergum and a sternum. Between these two plates are the lateral, or podial regions, from which the paired metameric limbs are developed. Whatever sclerotizations may occur in these podial regions are essentially sclerotizations of the limbs, of either a primary or secondary nature. However, the sclerotization of an adult abdominal segment of such an insect as the Carolina mantis could not be interpreted as having simply a tergum and sternum, with the metameric limbs secondarily suppressed and represented by the membranes between the dorsal and ventral plates. In the first place, the abdominal skelton has the secondary condition of segmentation, so both terga and sterna are not of a simple intrasomitic composition. In the second place, most of the abdominal limbs are present, though they do not appear as limbs. In the second to the seventh (inclusive) segments of this mantid (see figure 1, Plate XV) the limbs are flattened, and are integral parts of the functional abdominal sterna. How much of the functional sternum is true or primary sternum, and how much limb base, it is not possible to determine from the adult condition. In Thysanura most of the functional sternum is morphologically limb base, the true sternum appearing as a small medial triangle between the two laterally disposed limb bases.

* Smiths. Misc. Coll., 89, No. 8.

Since the terga and sterna are the two primary sclerotizations, and are separated from each other by the podial regions, the insect trunk is fundamentally divided, longitudinally, into four surficial areas by two pairs of lines. According to Snodgrass the membranous infolding below the spiracles (d-l l, figure 1) indicates the position of the dorsolateral line in the abdomen. The ventrolateral line is not so clearly indicated in the adult, because of the complete fusion of limb bases to the sterna.

Transversely the Carolina mantis abdomen is divided into at least ten somites. After a careful study it is obvious there are eleven abdominal somites in this insect, the eleventh being a reduced segment usually held retracted within the larger tenth. These somites can be grouped conveniently into three sets. The first seven are pregenital, the eighth and ninth are genital, and the tenth and eleventh are postgenital.

The skeleton of the pregenital segment (second to sixth, inclusive) is more generalized than that of the other segments. The tergum (II T-VI T, figure 1) is a broad shield to the somitic dorsum. Its structure indicates a simple expression of secondary segmentation. The intersegmental infolding (isg r, figure 11, Plate XVI) traverses the anterior margin of the tergum. The pretergite (Prt) is but a narrow border, yet quite distinct. The lateral edges of the terga of this insect contain the spiracles. These edges are made distinct from the remainder of the terga by longitudinal carinae, and they might be distinguished from the dorsal portions of the terga as paratergites (part, figure 1). The sternum, in spite of its complex composition, appears to be as simple a plate as the tergum, in the pregenital segment. It has a narrow presternite, and a slight intersegmental infolding. The lateral portions, the limb bases, are indistinguishable from the primary sternum. The relationships of these features, in the transverse plane, is shown in figure 10. The tergum (T) forms the upper half of the oval outline. Its paratergites (part) are usually bent inwardly. The sternum (St) forms the bottom half of the oval outline. Between these two plates are the lateral membranes. The dorsal portion of the podial area is indicated by the dorsolateral line (d-l l). When the female is gravid, and the eggs are large, the membranes become exposed and the paratergites are partially straightened. Figure 1 shows the female abdomen partly distended. Just prior to oviposition the abdomen is so distended the oval outline is changed into a nearly circular one.

In the gravid condition the female abdomen is distended not only transversely, but also longitudinally. Figure 11 is a sagittal section through the fourth segment. The intertergal (itg m) and the intersternal (ist m) membranes are rather ample, and if they are unfolded, the length of the abdomen is noticeably increased.

I have referred to the second to the sixth, inclusively, as the more generalized of the pregenital segments of the Carolina mantis. A second glance at figure 1 will disclose that the first and seventh segments differ from those between them. The tergum of the first segment is closely associated with the metathoracic tergum, its pretergite being in direct contact with the thoracic plate. The dorsal intersegmental infolding furnishes points of attachment for what remains of the dorsal longitudinal muscles. Another point of difference in the first tergum is its lack of paratergites. As in most Orthoptera, the first abdominal sternum is greatly reduced (see figure 16, 1 Ab St).

In the abdomen of the female Carolina mantis the sternum of the seventh segment is elongated and greatly enlarged to form a ventral cover for the ovipositor (see figures 1 and 3). There are some special terms for this ovipositor cover, but since some orthopterans have the eighth sternum as the ovipositor cover, it is better to discard terms that might indicate a homodynamous condition. Nothing much is gained by having such terms as "subgenital plate," "hypandrium," etc. I do not believe any entomologist is so busy that referring to the ovipositor cover as the seventh or eighth abdominal sternum, whichever it may be, is an imposition upon him, and the long designation can be abbreviated for labeling purposes.

THE GENITAL

Within this seventh abdominal sternum is an ovipositor mechanism which is the source of much controversy in regard to its morphology. One group of entomologists has interpreted the pterygotan ovipositor by comparing the more generalized pterygotan mechanisms with those of the Lepismatidae and Machilidae. The interpretation derived from this comparison appears creditable, and seems to explain the origins and forms of the pterygotan ovipositors. However, R. I. Nel, when he was at the Imperial College of Science and Technology, London, did some work on the development of the genital ducts and genitalia of certain orthopteran females, and he has questioned the value of comparative analyses of the adult structures.

Nel thought that the ventral collineae (the "valves," "valvulae") of *Blattella* are serially homologous with its dorsal collineae ("dorsal valves"), and that its medial collineae ("inner valves") are endite lobes, or apophyses of the gonopods of the ninth segment. No such apophyses, in *Blattella,* are developed from the gonopods of the eighth segment. This interpretation differs from Snodgrass' in that Snodgrass identifies the ventral collineae as apophyses of the gonopods of the eighth segment, serially homologous to the medial collineae. According to Snodgrass the gonopod proper of the eighth segment is reduced to form the collineafer (the "valvifer").

This controversy arises from two opinions, one that the value of comparative anatomy is greater than ontogenetic evidence, and the other that comparative analyses may be deceptive and that ontogenetic studies must form the basis for interpretation. To quote from Snodgrass,* ". . . it is quite a different matter to prove that these parts represent true segmental appendages. Even the fact that the first rudiments of the valvulae appear in some insects on the embryo in line with the vestigal appendages on the pregenital segments is not necessarily evidence that they are homodynamous with the latter, since secondary structures arising in the same relative positions as the true limbs would be very likely to assume the same form in early stages of growth. The best evidence of the origin of the ovipositor from the limb structures is furnished by the Thysanura."

But, Nel insisted,† "It has been generally accepted up to now—that in pterygote insects the anterior ovipositor valves (the "ventral valves") of segment 8 are serially homologous with the inner ovipositor valves of segment 9. My observations on *Locustana, Colemania,* and *Blattella* indicate that it needs revision. In these insects the ovipositor valves are first represented by two pairs of lobe-like outgrowths on the eighth and ninth sterna. The manner and place of origin of these rudiments leaves no doubt that they are serially homologous. Later the lobes on the ninth give rise to a pair of outgrowths on their mesal margins. The lateral structures of the ninth develop into the lateral ovipositor valves ("dorsal valves"), the mesal pair into the inner valves. No mesal outgrowths are differentiated from the lobes of the eighth sternum and they develop into the anterior ovipositor valves ("ventral valves").

* Page 48 (bottom), "The Abdominal Mechanisms of a Grasshopper," Smiths. Misc. Coll., 94, No. 6.

† Page 49 (middle), "Studies on the Development of Genitalia and Genital Ducts in Insects," Quart. Journ. Micr. Sci., 73 n. s., pp. 25-86.

In connection with the possible relationships of the pterygotan ovipositor with that of the machilid, Nel wrote (page 50, middle), "A comparison of the origin of the ovipositor lobes in young Orthoptera and in the young stages of the machilid *Petrobius carpenteri* Bagnall is instructive, and clearly shows that the anterior ovipositor valves (ventrals) of Orthoptera do not correspond morphologically with the ovipositor lobes of Machilidae but with the gonocoxites (limb-bases) of these insects." To which Snodgrass said (page 54, one third), "It may still be difficult to prove that the first valvulae (ventrals) are gonapophyses homodynamous with the second valvulae ('inner'), and not coxal processes corresponding with the third valvulae (dorsals); but the identical relations of the first and second valvulae to their respective valifers in most insects, and the fact that these valvulae constitute the usual blades in the shaft of the ovipositor, to which the third valvulae are mere ensheathing lobes, leaves little basis for questioning the apparent and generally accepted homologies of the ovipositor components."

Thus, we have two sets of interpretations, and the proponent of each appears to be certain of his ground. One of them must be in error, and, though I refuse to commit myself definitely in view of the meager evidence we have on hand, I am inclined to look upon ontogenetic evidence with more favor than upon comparative analyses of adult structures. Until ontogenetic work is proven inadequate for purposes of interpretation of insect structures, I shall interpret the ovipositor of the Carolina mantis from Nel's side of the fence.

The gonopods of the eighth and ninth abdominal segments of the Carolina mantis are shown from lateral views in figures 6 and 7, and from a ventral view in figure 2. The gonopods of the eighth segment form the ventral collineae (v Coll: derived from *collineare,* to direct in a straight line. Though this designation may be too specific if applied literally, we cannot use director, from *directus,* since it is too common. At least collinea is preferable to "valve"). These processes are oddly shaped; they are bowed at their bases. There are essentially two sclerotizations in each ventral collinea, a basal, the collineafer ($collf_8$), and a central sclerotization which encircles the main part of the process. The tip is membranous.

The gonopods of the ninth segment are more complex in structure. The main part of the gonopod forms the dorsal collinea (d Coll) and the collineafer ($collf_9$). The medial apophysis of this gonopod forms the medial collinea (m Coll, figures 2 and 7). The dorsal collinea is

better sclerotized than the ventral, but the medial collinea is entirely membranous. Figure 7 shows the relationship of the medial to the dorsal collinea from the mesal aspect. In this figure the medial collinea is separated from the dorsal, but the broken lines indicate points of contact. In figure 4 the relationship of these collineae, at their bases, is indicated. An odd feature is the articulation between the two processes.

The collineafer of the dorsal collinea is a triarticulated sclerite. Its dorsal point (1, figures 6 and 5) is in contact with the distal point of the fused paratergites of the eighth and ninth terga (part, figure 6). This articulation is the fulcral point from which the ventral collinea is slipped back and forth beneath the dorsal collinea. Point *2* is the articulation permitting movement between the collineafer of the ventral gonopod. Point *3* is the articulation between the dorsal collinea and its collineafer. The internal surfaces of these structures are shown in figure 5.

The terga of the genital segments are noticeably smaller than the preceding pregenital terga. The paratergites of both the eighth and ninth terga are greatly elongated, strongly sclerotized, and fused together to form suspension points for the collinear apparatus. It will be noted that no spiracles are in the paratergites of the ninth tergum. The sterna of the genital segments are as reduced as the paratergites are developed. What I identify as the eighth sternum is a small triangular plate between the bases of the anterior pair of gonopods (VIII St, figures 2 and 5). The sternum of the ninth segment appears to be split into two pieces, one which lies between the bases of the dorsal collineae (IX St_a), and the other between the medial collineae (IX St_b, figure 5).

My interpretation of the eighth sternum of the female Carolina mantis probably will be questioned since that sclerite is posterior to the gonopore of this insect. However, is it not more reasonable to call the sclerite between the bases of the ventral collineae the sternum of the eighth rather than to place that sternum morphologically anterior to the gonopore because it is said the gonopore is posterior to the eighth sternum? Nel's developmental studies, as well as those of Denny, Peytoureau, Bordas, Chopard, Wille, Vogel, and Ford, leave little doubt as to the position of the gonopore in female mantids and blattids; it is in the seventh intersternal membrane.

Figure 8 is a sagittal scheme of the distal portion of the female abdomen of the Carolina mantis. From this drawing we may see that the seventh sternum (VII St) is a long plate divided into two

regions by an infolding. The distal region may be the fused appendages of the seventh segment, or it may be merely a secondary constriction of the functional sternum. Above the seventh sternum is the folded and thickened intersternal membrane. The thicker portions of this membrane are somewhat sclerotized, and it is this sclerotization that has been identified as the eighth sternum of the Carolina mantis. The morphologically posterior part of the intersternal membrane is enlarged and invaginated to form a genital chamber (G C). The gonopore (Gpr) opens in the posterior part of the floor of this genital chamber. In the dorsal wall of the genital chamber is the eighth sternum (VIII St). Posterior to this sclerite is the opening to the spermathecal duct (Spm d). Between the two sclerites of the ninth sternum (IX St) empties the products of the colleterial glands (Col gl).

As to the morphology of the spermatheca Nel pointed out that it is not always homologous, that "the term spermatheca has a 'functional' rather than a 'morphological' significance." However, he does concur that the spermatheca of generalized Orthoptera is an ectodermal invagination of the eighth abdominal somite. Nel identifies the colleterial glands as invaginations of the ninth sternum. At least about these two invaginations there is no marked controversy. Singh-Pruthi thought the spermatheca an invagination of the ninth segment, primitively, but he worked with beetles and Nel has placed many questions in his way.

If it is wise to leave the interpretation of the morphology of the neck until after I study the development of the Carolina mantis, it would be wiser still to refrain from interpreting the male genitalia of this insect. The interpretation of these organs will require a careful study of the development of not only this mantid, but comparative ontogenetic studies of its relatives and of lower forms.

Figure 9, Plate XVI, is an angular lateral view, from the left side, of the distal abdominal structures of the Carolina mantis male. The eighth pair of spiracles (Spr) are contained in the paratergites of the eighth tergum. The sternum of this segment, in the male, is a large, well-sclerotized plate. Posterior to the eighth is the greatly elongated ninth sternum. The form of this sternum indicates its composition; the basal portion is the primary sternum, and the distal portion is of the fused limb bases of this segment. The telopodites of these limb bases are retained as the styles (Sty), in the adult.

Above this scoop-shaped ninth sternum are the male genitalia. Though they appear to be highly complicated, these organs can be

separated into three definite groups, or lobes. These lobes are drawn separated from each other in figures 12 and 16. The medial lobe (M L) is ventral in position, in relation to the other two. It carries the gonopore (Gpr, figure 12) in its membranous dorsal surface. Its ventral surface is well sclerotized and the distal point of this sclerotization is drawn into a recurved hook. The right lobe (R L) is the dorsal most in position; it is the least developed of the lobes. The outer edge is supported by a peaked sclerite, and ventrally there is a transverse band. In contrast to this simple lobe is the complicated lobe to the left and above the medial lobe (L L). Its ventral sclerites terminate in two curved hooks. A curious membranous evagination, resembling vaguely a bird head, projects from the posterior portion of the dorsal membrane of the left lobe.

In the young male mantid three lobes emerge from the posterior region of the ninth venter. Two of these lobes are lateral in position, and the third is ventral in position and carries the gonopore. This ventral lobe becomes the medial of the adult male, the left lateral forms the complicated left lobe, and the right lateral lobe becomes the simple right lobe of the adult male. The two laterally disposed lobes have been identified as the apophyses of the gonopods of the ninth segment. Snodgrass, however, finds nothing in these two lobes to suggest they have any relation to the gonopod bases. The last word concerning the orthopteran male genitalia has not been said.

The postgenital segments appear to be simple, yet they are not so simple that the interpretation of their morphology is free from controversy. Concerning the tenth segment there is little question. Some would have the cerci as the appendages of this somite, but in embryological studies it has been commonly observed that the limb rudiments of the tenth abdominal somite are suppressed before hatching, and that the cerci are the metameric appendages of the eleventh segment. The association of the cerci with the tenth tergum is a secondary condition. The sternum of the tenth segment is not apparent in the Carolina mentis.

There is considerable doubt about the morphology of the eleventh segment. In this mantid the eleventh segment is not part of the tenth, but is a distinct structure held retracted within the tenth. From figure 14 the relation of the eleventh to the tenth segment may be seen from the sagittal plane. The tergum of the eleventh (XI T, figure 15) is a small, triangular, weakly sclerotized plate lying beneath the stronger tenth tergum. On either side of the anus (A) are the two paraprocts (Papt). These sclerites have been called

the split halves of the eleventh sternum, and, some have maintained that the anterior portions are parts of the tenth sternum and the posterior parts are of the eleventh sternum. Crampton (1929) considered the paraprocts to be the limb bases of the cerci. I rather suspect this is true. In the Carolina mantis, at least, it seems that the functional bases of the cerci (see figures 13 and 15) are not the morphological bases. The articulation of the cerci to the tenth tergum is definitely a secondary association. It is hoped that a careful study of the ontogeny of the mantis, with the aid of newer technique methods, will indicate the solution of many of these fundamental questions about the Carolina mantis.

GENERALIZATIONS

The abdominal skeleton of the Carolina mantis is very generalized for that of a pterygotan insect. Most of the terga have the edges distinct as paratergites. In the eighth and ninth terga of the female the paratergites are strongly developed to form suspension points for the collinear apparatus. The sterna are simple in appearance; the first sternum is quite reduced, but distinct. In the female the seventh sternum is enlarged to form an ovipositor cover. In the male the form of the ninth sternum indicates its composition of primary sternum and metameric appendages. The male genitalia are peculiarly twisted lobes, three in number, and undoubtedly the derivatives of the three lobes of the immature male mantid. The eleventh segment is reduced, but distinct; it is retracted within the tenth. The cerci are relatively long, hairy, and annulated. The female ovipositor is a simple pterygotan mechanism. The female gonopore opens upon the seventh intersternal membrane, and the male gonopore upon the medial lobe of the genitalia.

SYNONYMIC TERMS FOR THE ABDOMINAL SKELETON

New terms	*Older equivalents*
Collineafer	valvifer
Dorsal collinea	dorsal, or third valve
Genital segment	eighth or ninth abdominal segment
Intersegmental infolding	antecosta
Lateral membrane	pleural membrane
Medial collinea	inner, or second valve
Podial area	limb-base area
Postgenital segment	tenth or eleventh abdominal segment
Pregenital segment	any of the first seven abdominal segments
Presternite	acrosternite
Pretergite	acrotergite
Sternum	sternite
Tergum	tergite
Ventral collinea	ventral, or first valve

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TABLE OF ABBREVIATIONS

A ..... anus
art ..... articulation
Cer ..... cercus
Col d ..... colleterial duct
collf ..... collineafer
c Ovd ..... common oviduct
d Coll ..... dorsal collinea
d l l ..... dorsolateral line
Ej d ..... ejaculatory duct
G C ..... genital chamber
Gpr ..... gonopore
ist m ..... intersternal membrane
itg m ..... intertergal membrane
L b ..... limb-base
L L ..... left lobe
m Coll ..... medial collinea
M L ..... medial lobe
part ..... paratergite
Parpt ..... paraproct
R L ..... right lobe
Spm d ..... spermathecal duct
Spm p ..... spermathecal pore
Spmt ..... spermatheca
Spr ..... spiracle
St ..... sternum
Sty ..... style
T ..... tergum
v Col ..... ventral collinea

PLATE XV

FIGURE

1. Lateral view of female abdomen.
2. Ventral view of ovipositor.
3. Angular lateral view of terminal segments of female.
4. Base of right gonopod of ninth segment.
5. Base of ovipositor from inner view.
6. Lateral view of ovipositor.
7. Mesal surfaces of gonopod of ninth segment.
8. Sagittal section through terminal segments of female.

PLATE XV

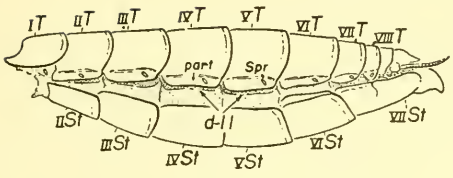

FIG. 1

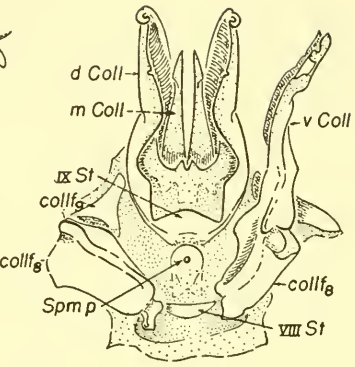

FIG. 2

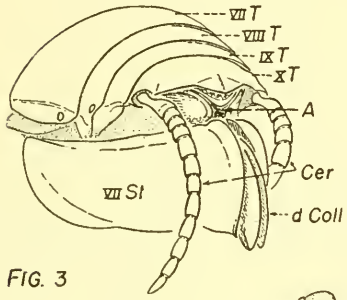

FIG. 3

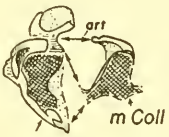

FIG. 4

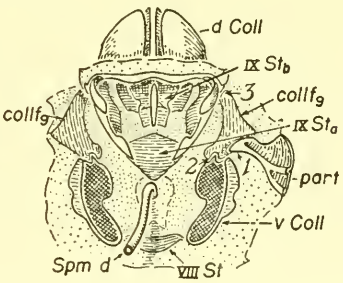

FIG. 5

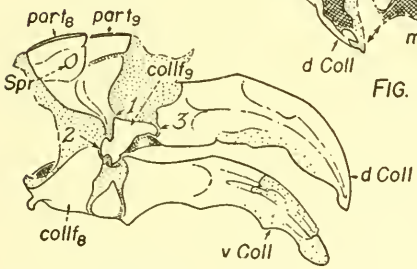

FIG 6

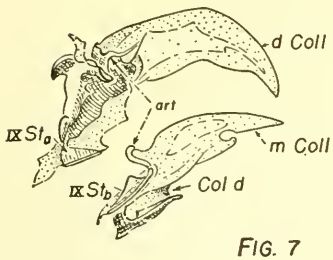

FIG. 7

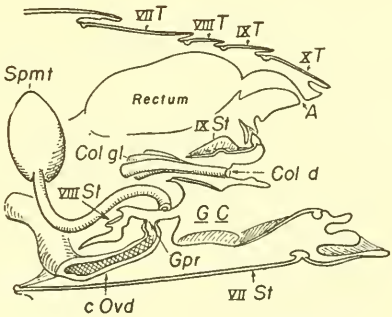

FIG. 8

PLATE XVI

FIGURE

9. Angular lateral view of male terminal segments.
10. Cross-section of pregenital segment.
11. Sagittal section of pregenital segment.
12. Dorsal view of male genitalia, separated.
13. Base of left cercus.
14. Sagittal section through postgenital segments.
15. Ventral view of eleventh segment.
16. Ventral view of male genitalia separated.

PLATE XVI

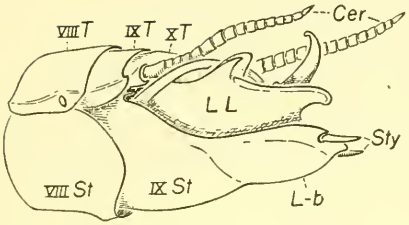

FIG. 9

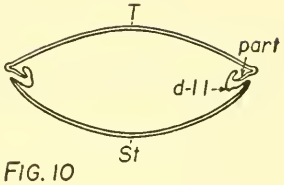

FIG. 10

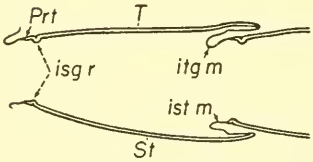

FIG. 11

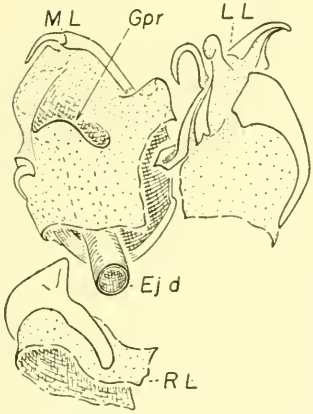

FIG. 12

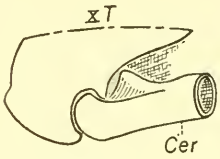

FIG. 13

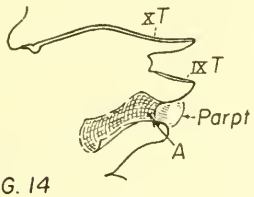

FIG. 14

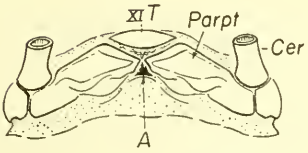

FIG. 15

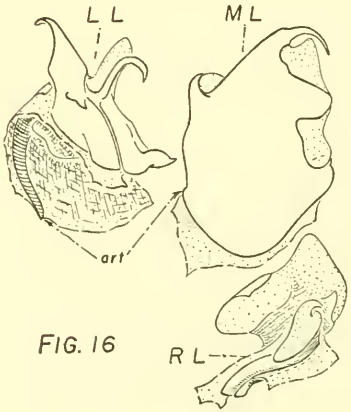

FIG. 16

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Species of Erythroneura of the Comes Group (Homoptera-Cicadellidae)

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ABSTRACT: North American species of Erythroneura (grape leaf hoppers) of the Comes group are reviewed. Seventy species and varieties are included. One was unrecognizable: (*E. oetonotata* Walsh), seventeen are placed in synonymy: *E. vitis* var. *flava* Robinson and *E. vitis* var. *venusta* McA. (= *E. vitis* (Harris) n. syn.); *E. fusco-flava* Beamer (= *E. bistrata* McA. n. syn.); *E. rubranotum* Rob. (= *bistrata* var. *stricta* McA. n. syn.); *E. tricincta* var. *rubravitta* Rob. (= *diva* McA. n. syn.); *E. tricincta* var. *erasa* McA. (= *E. calycula* McA. n. syn.); *E. breakeyi* Johnson (= *E. pontifex* McA. n. syn.); *E. mallochi* McA. (= *E. rosa* Rob. n. syn.); *E. portea* Rob. (= *E. reflecta* McA. n. syn.); *E. attenuata* Johnston (= *E. nudata* McA. n. syn.); *E. tudella* Rob. and *E. scripta* Rob. (= *E. delicata* var. *accepta* McA. n. syn.); *E. ornata* Osb. (= *E. corni* Rob. n. syn.); *E. comes* var. *suffusa* McA. (= *E. bidens* McA. n. syn.); *E. irrorata* Rob. (= *E. rubra* (Gill.) n. syn.); *E. cherokee* Rob. and *nigroscuta* Johnson (= *E.* compta McA. n. syn.); and the following are described as new: *E. prima, E. festiva, E. tacita, E. ziczae* var. *walshi*. All existing types have been examined. Drawings of male genitalia, keys to groups, species and varieties are included. Types of the new species are in the Snow collection, University of Kansas, Lawrence, Kan.

INTRODUCTION

IN this paper I have attempted to bring together all of the North American species of Erythroneura of the Comes group as defined by Wm. Robinson, University of Kansas Sci. Bul., vol. XVI, March, 1926. Seventy species and varieties are treated. One of this number was not recognizable, eighteen are placed as synonyms and four are described as new. All existing types have been studied, most of the males dissected and the internal genitalia figured.

It is this group to which most of our economic grape leaf hoppers

belong. The cultivated grape is without doubt the greatest sufferer, with the majority of the species and varieties listed feeding on this host. Virginia creeper, Boston ivy, red bud, willow and various species of dogwood are also hosts to some of the forms.

GROUPS OF ERYTHRONEURA

The genus Erythroneura was divided into six groups by W. L. McAtee, Trans. Amer. Ent. Soc., vol. XLVI, 1920. Wm. Robinson in Univ. of Kan. Sci. Bul., vol. XVI, No. 3, March, 1926, further revised the genus into five groups, giving them names instead of numbers, as did McAtee. After the dissection of many thousands of specimens I propose a further revision into four groups. It was found that the Scutelleris and Maculata groups of Robinson vary from one to the other and the genitalia were more or less of one type. The Scutelleris group is therefore dropped. It must always be borne in mind when using wing veins as diagnostic characters that they are variable. In general, however, they follow the characters pointed out in the keys.

KEY TO GROUPS OF ERYTHRONEURA

1. M-Cu cross vein present 2
   M-Cu cross vein usually absent, media and cubitus forming a more or less continuous line 3
2. Base of cell M_4 curved; two posteriorly diverging vittae usually present on vertex and pronotum .....*obliqua group*
   Base of cell M_4 angulate; vertex and pronotum not marked as above; cross veins usually white .....*vulnerata group*
3. Base of cell M_4 oblique; apex of cell R_3 without black spot....*maculata group*
   Base of cell M_4 square; apex of cell R_3 with black spot or cloud....*comes group*

KEY TO THE SPECIES AND VARIETIES OF ERYTHRONEURA OF THE COMES GROUP

1. Color markings of dorsum one or more transverse bands or, solidly colored..... 2
   Color markings of dorsum not transverse bands nor solidly colored..... 16
2. (1) Dorsum infuscated throughout .....(1) *infuscata* (Gill.), p. 265
   Dorsum cross-banded (not so definite in *E. bistrata*)..... 3
3. (2) Dorsum with one crossband .....(2) *amanda* McA., p. 265
   Dorsum with more than one crossband 4
4. (3) Anterior crossband covering base of tegmina 5
   Anterior crossband not covering base of tegmina 8
5. (4) Usually a semblance of inverted V on vertex; last abdominal segment of male more or less infuscated 6
   Markings of vertex usually confined to a wide basal spot; last ventral segment of male stramineous 7
6. (5) Markings of dorsum distinct bands .....(3) *vitis* Harris, p. 266
   Markings of dorsum almost solid; light areas confined to a circle of spots *vitis* var. *corona* McA., p. 267
7. (5) Color of dorsum often almost solid, all bands more or less connected (4) *bistrata* McA., p. 267
   Color of dorsum in distinct crossbands .....*bistrata* var. *stricta* McA., p. 268
8. (4) Anterior crossband involving base of scutellum 9
   Anterior crossband not involving base of scutellum 13

9. (8) Anterior crossband covering all of pronotum except small part of anterior margin 10
Anterior crossband leaving most of disc of pronotum bare 12
10. (9) Crossbands one and two of different colors.....*rosa* var. *repitita* McA., p. 282
Crossband one and two same color..... 11
11. (10) Crossband one and two sanguineous to black.....(5) *tricincta* Fitch, p. 268
Crossbands one and two bright red.....(6) *diva* McA., p. 269
12. (9) All crossbands continuous .....(7) *calycula* McA., p. 270
Crossbands broken .....*calycula* var. *noncincta* John., p. 270
13. (8) Crossband one covering most of pronotum 14
Crossband one leaving most of disc of pronotum uncovered 15
14. (13) Crossband one sanguineous to dusky .....(8) *integra* McA., p. 271
Crossband one bright red.....*diva* var. *complementa* McA., p. 269
15. (13) Crossband continuous across hind margin of pronotum..(9) *cymbium* McA., p. 271
Crossband broadly interrupted on hind margin
cymbium var. *disjuncta* McA., p. 272
16. (1) Angulate vittae continuous from humerus to crossveins 17
Angulate vittae not continuous from humerus to crossveins 40
17. (16) Without definite colored spot on apex of clavus 18
With a definite colored spot on apex of clavus 20
18. (17) Marking of vertex a broad stripe .....(1) *fraxa* Rob., p. 272
Markings of vertex definitely V-shaped 19
19. (18) Elytral markings narrow, of uniform width, red or orange
(11) *acuticephala* Rob., p. 272
Elytral markings broad, of varying widths, brownish....(12) *elegans* McA., p. 273
20. (17) Basal two thirds of clavus bright red.....*compta* var. *rufomaculata* McA., p. 292
Basal two thirds of clavus not bright red 21
21. (20) Dorsum from base of scutellum to crossveins occupied by a light diamond-shaped spot .....(13) *cancellata* McA., p. 273
Dorsum not occupied by a large light spot 22
22. (21) Pronotum usually redbrown to black (lateral margins light in *E. aclys* McAtee) 23
Pronotum not redbrown to black 25
23. (22) Lateral margins of pronotum light .....(14) *aclys* McA., p. 274
Lateral margins of pronotum dark 24
24. (23) Vertex reddish brown .....(15) *prosata* Johnson, p. 275
Vertex light with red marks .....(16) *ziczac* Walsh, p. 275
25. (22) Basal angles of scutellum usually with large black spots 26
Basal angles of scutellum without definite back spots 27
26. (25) Vertex sharp pointed, tube of aedeagus projecting, posterior point of style almost as long as foot .....(17) *elegantula* Osb., p. 277
Vertex blunt, apex of aedeagus truncate .....(18) *coloradensis* (Gill.), p. 277
27. (25) Red markings of clavus overlaid with velvety black, (14) *palimpsesta* McA., p. 278
Red markings of clavus not overlaid with black 28
28. (27) Principal markings of vertex two black fingerlike marks, (2) *pontifex* McA., p. 279
Principal markings of vertex not two black fingerlike marks..... 29
29. (28) Median longitudinal red vitta on vertex .....(21) *kanwakae* Rob., p. 279
Markings of vertex not a median vitta 30
30. (29 Main dorsal vittae more or less darkened; posterior point of style much shorter than foot (except in *reflecta*) 31
Main dorsal vittae orange; posterior point of style longer than foot (except in *ancora*) 37
31. (30) Markings of dorsum lighter, scarcely any dark color 32
Markings of dorsum distinctly dark colored 33
32. (31) Processes of aedeagus coiled near middle (Ariz.) ....(22) *anfracta* Beamer, p. 280
Processes of aedeagus not coiled near middle .....(23) *vitifex* Fitch, p. 28
33. (31) Color markings of vertex usually enclosing three round white dots 34
Color markings of vertex not enclosing three round white dots 35
34. (33) Basal angles of scutellum usually dark; outer processes of pygofer hook about one fourth as long as inner, sides of aedeagus rounded
(24) *caetra* McA., p. 281

Basal angles of scutellum usually not so dark; outer processes of pygofer almost absent; aedeagus in dorsoventral view with sides almost parallel
(25) *rosa* Rob., p. 282

35. (33) Zigzag vittae of dorsum even sided; processes of aedeagus in lateral view not narrowed suddenly 36
Zigzag vittae of dorsum enlarged over disc of elytra, usually forming a complicated pattern; processes of aedeagus in lateral view rapidly narrowed near middle .....(26) *reflecta* McA., p. 283

36. (35) Zigzag vittae of dorsum narrower and more definite; pygofer hook U-shaped with two processes.....*ziczac* var. *walshi*, n. var., p. 276
Zigzag vittae of dorsum more suffused; pygofer hook with three processes .....(27) *prima* n. sp., p. 283

37. (30) Usually dorsal markings very narrow; aedeagus in dorsoventral view broad, bell-shaped, processes scarcely diverging.....(28) *nudata* McA., p. 284
Dorsal markings usually heavier; aedeagus not as above 38

38. (37) Aedeagus in dorsoventral view narrow, many times longer than wide 39
Aedeagus in dorsoventral view broad, not much longer than wide
(29) *beameri* Rob., p. 285

39. (38) Posterior point of style longer than foot.....(30) vaga Johnson, p. 285
Posterior point of style much shorter than foot.....(31) *ancora* Beamer, p. 285

40. (16) Markings of vertex usually more than an inverted V..... 41
Markings of vertex usually not more than an inverted orange V or a median stripe 50

41. (40) Markings of clavus usually consisting of three spots (*E. omaska* may have just two) 42
Markings of clavus consisting of two spots 44

42. (41) Markings of dorsum heavy; milky colored background not so evident; shaft of aedeagus in dorsoventral view narrow, tip bifid..(32) *omaska* Rob., p. 286
Markings of dorsum very delicate; general ground color milky white; aedeagus in dorsoventral view broad 43

43. (42) Median spot of clavus without dark spot .....(33) *delicata* McA., p. 286
Median spot of clavus with dark spot .....*delicata* var. *accepta* McA. p. 287

44. (41) Vertex with dark median line 45
Vertex with light median line 48

45. (44) Vertex and pronotum often suffused with brown 46
Vertex and pronotum not suffused with brown 47

46. (45) Processes of pygofer hook almost touching at apex .....(34) *corni* Rob., p. 287
Outer process of pygofer hook slightly more than half as long as inner; tip of latter enlarged .....(35) *bidens* McA., p. 287

47. (45) Aedeagus in dorsoventral view one half as broad as long, (36) *rubrella* McA., p. 288
Aedeagus in dorsoventral view very narrow, many times longer than wide
(37) *ontari* Rob., p. 289

48. (44) Body very dark, showing through elytra..... 49
Body light, not darkening upper surface .....(38) *aza* Rob., p. 289

49. (48) Markings of dorsum broad; posterior point of style short, (39) *rubra* (Gill.), p. 290
Markings narrow; posterior point of style as long as foot, (40) *festiva* n. sp., p. 290

50. (40) Usually some dark markings on scutellum and on anchor-shaped spot of clavus .....(41) *compta* McA., p. 291
No dark markings on scutellum and on anchor-shaped spot of clavus..... 51

51. (50) Process of aedeagus in lateral view with notch or projecting point near middle .....(42) *comes* (Say), p. 292
Process of aedeagus without such a notch 52

52. (51) Markings of vertex a median longitudinal vittae .....(43) *tacita* n. sp., p. 293
Markings of vertex usually V-shaped 53

53. (52) Aedeagus in dorsoventral view broad, bell-shaped; outer process of pygofer hook not over half as long as inner .....*nudata* McA., p. 284
Aedeagus in dorsoventral view broad but strongly constricted on basal half; outer process of pygofer hook almost as long as inner..(44) *gilensis* Beamer, p. 293

1. *Erythroneura infuscata* (Gillette)

Typhlocyba comes var. *infuscata* Gillette, C. P. Am. Typhlocybinae, 1898, p. 764.

The only specimen mentioned in the original description was type number 3451 in the United States National Museum. This description, a very short, terse one, does not fit this type 3451. W. L. McAtee, Trans. Am. Ent. Soc., vol. XLVI, 1920, redescribed the type as follows: "Smoky brown to black above, in some cases underlaid by deep dull red, a little paler at rondure of vertex, especially on sides, pronotum sometimes faintly paler on disc, and scutellum sometimes with a pale median vitta; tegmina with more or less hyaline spots at base, middle and apex of inner margin of clavus, middle of radial margin of fourth apical cell and on costal margin of second apical cell; costal plaque opaque whitish, tinged with red, an almost equal area of dull red just posterior, and costal margin and to some extent the crossveins pencilled with dull red. Face and legs pale yellow, abdominal incisures, etc., sometimes pale yellow."

Genitalia. Pygofer hook U-shaped, outer process about half as long as inner. Foot of style medium, heel small; base almost straight; anterior point about half as long as width of foot; posterior point shorter and sharper. Aedeagus in dorsoventral view broad, tube projecting sharply, lateral margins narrowing rapidly toward base.

This beautiful dusky species is quite common throughout the United States east of the Rocky Mountains.

2. *Erythroneura amanda* McA.

Erythroneura comes var. *amanda* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 319, 1924.

This striking species is easily separated from all others in the Comes group by the large, almost triangular, reddish brown spot which occupies most of clavus, corium between clavus and costal plaque and apex of scutellum. The male genitalia show a very close relation with *E. compta* McA., from which it differs only in minor details. If the external markings were like that species it would be difficult indeed to separate them.

Genitalia. Pygofer hook U-shaped. Foot of style large; heel short and sharp; base straight; anterior point short, sharp; posterior point longer than foot, almost parallel-sided. Aedeagus in ventral view rather broad, diamond-shaped, with each process bifid.

This species differs from *compta* in having the base of the processes of the aedeagus somewhat heavier and in the sides of the pygofer hook being longer.

Specimens are at hand from Douglas, Atchison, Cherokee and Wyandotte counties, Kansas.

3. *Erythroneura vitis* (Harris)

Tettigonia vitis Harris, T. W., Encyclopedia Americana, VIII, p. 43, 1831.
Erythroneura vitis var. flava Robinson, Can., Ent., vol. LVI, No. 3, p. 62; 1924.
Erythroneura vitis var. *venusta* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 319, 1920.

The original description is as follows: "It may be called *tettigonia vitis* (Harris). It is, in its perfect state, nearly one tenth of an inch long; of a straw color, with two broad, scarlet bands across the wing cases, one at the base and the other on the middle, and the tips of the wing cases are blackish."

General ground color yellowish white. Vertex marked with pair of reddish, longitudinal arcs, probably remnant of orange inverted V. Pronotum of type male, red on lateral margins, much lighter on median two thirds with darker Y-shaped mark at middle. Most specimens are uniformly dark reddish-brown throughout most of surface. Scutellum of type buff with two longitudinal pink stripes and pink tip. Elytra with base and median band bright red. Anterior cross band wider than scutellum on costal margin, narrower next scutellum. Median band not quite covering tip of claws. Costal plaque with large black spot, cross veins more or less red, beyond infuscated. Venter more or less straminеous, mesosternum usually darker and last ventral segment of male darkened.

Genitalia. Style with foot short; heel moderate; base curved; anterior point sharp, slightly longer than posterior; posterior point narrower and shorter, about half as long as base. Aedeagus small, tip broad, sharply narrowed on basal two thirds. Pair of heavy almost parallel processes, longer than aedeagus, almost straight.

Type in collection of Boston Society of Natural History.

This species is usually easily separated from closely related forms by the semblance of an inverted V on the vertex and the darkened last ventral segment of the male.

Through the courtesy of the board of directors and Mr. Richard Dow, of the Boston Society of Natural History, I was able to study the male genitalia and a water color of the type.

This is a common species on grape throughout the United States east of the Rocky Mountains.

Erythroneura vitis var. *corona* McAtee

Erythroneura vitis var. *corona* McAtee, W. L., Trans. Am. Ent. Soc., 46, p. 305, 1920.

Original description. "Similar to variety *vitis* Harris, but middle crossband on tegmina connected by red lines along longitudinal veins to anterior crossband and to ramose marking on cross veins, so that the saddle mark appears to be surrounded by a wreath of pale spots."

A study of male genitalia of specimens with the above markings shows no marked difference from *vitis* Harris. The markings are so characteristic, however, that the varietal name is retained.

Type, female, Plummer's Island, Maryland, in collection of McAtee. Since McAtee did not designate an allotype a male from Windsor, Vermont, 21, VIII, 1934, R. H. Beamer, is here so designated.

This variety is even more plentiful on grape than *E. vitis* over the same territory. The same dark last ventral segment in the male and the inverted V of the vertex, as in *E. vitis,* separate this species from the *E. bistrata* forms and the enlarged middle band encircled with a ring of white spots sets it off from *E. vitis.*

4. *Erythroneura bistrata* McAtee

Erythroncura vitis var. *bistrata* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 305, 1920.

Erythroneura fusco-clava Beamer, R. H., Can. Ent. 1927, p. 31, LIX.

Original description. "This variety illustrates the extreme degree of erythrization of this species I have seen; the vertex may be pale yellow, but usually it has the normal pair of vittae strongly developed, and it may be almost entirely red; the pronotum is red with touches of pale yellow on anterior border, with a dot in middle and traces of pale yellow at about two points on the hind margin; scutellum red with a pale median vitta enlarged at apex; tegmen often entirely red with the exception of a pale spot at inner base of clavus and another involving apex of clavus and adjoining corium; there may be other traces, however, of both anterior and posterior pale bands, and the costal plaque, except for its posterior blackish marking, and an equal sized area behind it and the bases of the apical cells are pale; undersurface and legs chiefly pale yellow."

Dissection of the male type revealed a type of genitalia sufficiently different from *E. vitis* (Harris) to be worthy of specific rank.

Genitalia. Pygofer hook typically U-shaped. Foot of style of medium length, heel definite; base almost straight; anterior point

short and sharp, about as long as foot is wide inside points; posterior point about two thirds as long as foot, slightly wider at base than anterior, sides almost straight, converging to sharp point. Aedeagus in dorsoventral view more or less diamond-shape, widest near middle and tapering to rather narrow apex and slightly wider base. Aedeagal processes rather slender, reaching almost to tip of shaft, then bending at right angles for about one third their length.

Type male in the collection of W. L. McAtee.

As Mr. McAtee states in the description, this species is quite variable in color pattern. The vertex markings, however, are usually just rectangular spots covering most of base, leaving outer third, at least, unmarked. This and lack of the darkened last ventral segment in the male easily separates this form and *E. bistrata* var. *stricta* McAtee from *E. vitis* (Harris) and its variety.

It occurs in large numbers in some localities, but not so plentiful usually as the variety *stricta*.

Erythroneura bistrata var. *stricta* McAtee

Erythroneura vitis var. *stricta* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 305; 1920.
Erythroneura rubranotum Robinson, Wm., Can. Ent., vol. LVI, No. 3, p. 60; 1924.

Original description. "Ground color whitish hyaline to pale yellow; vertex chiefly pale, sometimes with a few touches of red, pronotum and scutellum chiefly pale, sometimes with a few touches of red, pronotum and scutellum chiefly red to dusky, the latter sometimes pale medianly and at tip; tegmen with three crossbands, the anterior red, narrow, not exceeding scutellum, the middle one narrower than in the other varieties, usually nearly quadrilateral in shape; the posterior much as in first variety, pale spaces between the bands broader than in the other varieties; usually half or more of costal plaque bluish or blackish, often overlaid by opaque white; lower surface stramineous to pale yellow."

Dissections of males of this variety exhibit the same type of genitalia as *E. bistrata*, so it is given as a variety of that species. The vertexal marks and the color of the last ventral segment of the male are the same as in that species.

This is a very common variety, often occurring in great numbers on grape. Distribution same as for *E. bistrata*.

5. *Erythroneura tricincta* Fitch

Erythroneura tricincta Fitch, Asa, N. Y. State Cab., p. 63, 1851.

Original description. "Three-banded Erythroneura, *E. tricincta*. Pale yellow, with three broad bands, the anterior velvet-black, oc-

cupying the thorax and basal half of the scutel; the middle bright ferruginous ending outwardly in black, forward of the middle of the elytra, the posterior dusky brown, on the apex. Length, 0.12. No. 823, female."

Genitalia. Pygofer hook U-shaped, outer process about one third as long as inner. Foot of style medium; heel medium; base slightly curved; anterior point broad, almost as long as toe is wide; posterior point less than half as long, sharp. Aedeagus in dorsoventral view broad, tube projecting, processes longer than shaft, in lateral view bent around tip of shaft. This is the outstanding internal character in separating this form from *E. calycula* McA.

Even though a very short description, it is very good and one should have no trouble in determining this insect. It is very common throughout the eastern half of the United States and Canada.

6. *Erythroneura diva* McAtee

Erythroneura tricincta var. *diva* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 308; 1920.
Erythroneura tricincta var. *rubravitta* Robinson, Wm., Can. Ent., vol. LVI, No. 7, p. 156; 1924.

Original description. "Crossbands one and two chiefly bright red; crossband one covering most of pronotum and base of scutellum, where its color sometimes is brownish yellow instead of red; crossband two, bright red to costal plaque which is chiefly blackish, more or less overlaid by opaque white; longitudinal color markings sulphur yellow."

Genitalia. Pygofer hook U-shaped, outer process almost as long as inner. Foot of style medium; heel almost absent; base straight; anterior point broad, almost as long as toe is wide; posterior point sharp and short, not more than one third as long as anterior. Aedeagus in dorsoventral view broad, almost circular, processes about as long as shaft with tooth near middle on outside margin. It is this tooth that is the distinctive internal character of this species.

Since this species was described from a holotype female, a male paratype, Plummer's Island, Md., Jan 23, 1916, W. L. McAtee, described above, is here designated allotype.

A fairly common species throughout the eastern half of the United States.

Erythroneura diva var. *complementa* McA.

Erythroneura tricincta var. *complementa* McAtee, W. L., Ill. Nat. Hist. Surv., vol. XVI, Art. III, p. 135; 1926.

Original description. "Crossbands one and two bright red, three dusky, differing from var. *diva* McA. in crossband one being confined to pronotum; subsidiary markings yellow. Length, 2.75 mm.

"*Holotype.* Female, Ocean Springs, Miss., Aug. 4, 1921, C. J. Drake."

Numerous specimens of this beautiful insect from Orange county, Texas, have been studied with no real difference becoming apparent between it and *E. diva* McA. other than the darker base of the scutellum in *diva*. In my estimation it is but the summer form of this species.

Specimens are at hand from Orange county, Texas, Inverness, Hilliard, Wildwood and Fort Meade, Fla.

7. *Erythroneura calycula* McAtee

Erythroneura tricincta var. *calycula* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 308, 1920.

Erythroneura tricincta var. *erasa* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 309, 1920.

Original description. "Ground color ivory, a broad U-shaped dusky to black band on base of scutellum and sides of pronotum, the often concolorous eyes extending it on vertex; crossband two sanguineous to dusky, black on costa; longitudinal color streaks red."

This is a beautiful, quite definitely marked species and the color of the first crossband, as described by McAtee, will separate it from all others.

Genitalia. Pygofer hook U-shaped, outer process about one third as long as inner. Foot medium; heel medium; base almost straight; anterior point wide, as long as toe; posterior point sharp, not over one third as long as the anterior. Aedeagus in dorsoventral view broad, tube very slightly projecting, processes about as long as shaft not curved around the tip in lateral view.

Common on grape throughout the eastern half of the United States and Canada.

Erythroneura calycula var. *noncincta* Johnson

Erythroneura tricincta var. *noncincta* Johnson, Dorothy M., Ohio Jr. Sci. No. 4, p. 261, 1934.

Original description. "There are no true crossbands in this variety which is closely related to *Erythroneura tricincta* var. *calycula* McAtee, as the basal angles of scutellum and sides of pronotum behind the black eyes are dark. There are dark reddish triangular spots, bordering side of costal plaques, and not attaining clavi which are immaculate. The background is creamy white and faint yellow-colored streaks follow the longitudinal veins of the elytra. The cross veins are narrowly black, heavily margined anteriorly, except the fourth, with bright red; apical cells dusky."

This is a variety of doubtful validity although a few specimens are at hand from Louisiana. It occurs very rarely.

8. *Erythroneura integra* McAtee

Erythroneura tricincta var. *integra* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 309, 1920.

Original description. "Crossband one, sanguineous to dusky, confined to pronotum, most of which it covers; crossband two bright red to sanguineous, bluish to black on costa; longitudinal color markings red."

A very distinctive species marked as described above.

Genitalia. Pygofer hook U-shaped, outer process very short, about one fourth as long as inner. Foot of style medium; heel small; base curved; anterior point broad, about as long as width of foot in narrowest place; posterior point narrow, sharp, about one fourth as long as anterior. Aedeagus in dorsoventral view almost circular, tube projecting, processes about as long as shaft, slightly diverging on outer half.

A male paratype, Plummer's Island, Md., March 18, 1917, W. L. McAtee, described above, is here designated allotype. Holotype female, allotype, and paratypes in McAtee collection. Fairly common throughout the eastern half of the United States.

9. *Erythroneura cymbium* McAtee

Erythroneura tricincta var. *cymbium* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 310, 1920.

Original description. "Crossband one, dusky to black, confined to pronotum, profoundly emarginate anteriorly, leaving a large part of disk uncolored; crossband two, sanguineous to red, bluish to black on costa; longitudinal color streaks yellow."

Genitalia. Pygofer hook U-shaped, outer process almost as long as inner. Foot of style medium; heel marked; base curved; anterior point broad at base, almost as long as width of foot; posterior point, short, sharp, about one third as long as anterior. Aedeagus in dorsoventral view almost circular, tube slightly projecting, processes about as long as shaft, slightly diverging on outer third.

A common species over the eastern half of the United States. Holotype female, Pennsylvania, in collection of W. L. McAtee. Allotype male, described above, White county, Illinois, March 31, 1929, in Snow Entomological Collection.

Erythroneura cymbium var. *disjuncta* McAtee

Erythroneura tricincta var. *disjuncta* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 310, 1920.

Original description. "Like the last, *cymbium*, but crossband (if it may be so called) one, broadly interrupted in the middle, covering only sides of pronotum."

A variety of doubtful value, but sometimes occurring. A few specimens are at hand from Louisiana and Illinois.

10. *Erythroneura fraxa* Rob.

Erythroneura fraxa Robinson, W. M., Can. Ent., vol. LVI, No. 12, p. 292; 1924.

This beautiful red marked species described by Robinson from a single female has since been found in numbers. A male specimen from Anderson county, Kansas, November 26, 1927, is figured as the allotype.

Genitalia. Pygofer hook of typical U-shape with points of U rather shorter than usual. Style with small foot; base almost straight; anterior point short, and sharp; posterior point about half as long as base and quite sharp. Aedeagus in ventral view rather bluntly diamond-shaped with slender processes roundingly separated.

This species resembles *E. kanwakae* Rob., but is larger, vertex blunter, orange spot of vertex in form of round spot rather than parallel-sided stripe, spot on tip of clavus more just an indication of a spot, seemingly about to disappear, pygofer hook with but two prongs and aedeagus in dorsoventral view more diamond-shaped than rectangular.

Numerous specimens at hand from Kansas, Arkansas, and Illinois.

11. *Erythroneura acuticephala* Robinson

Erythroneura acuticephala Robinson, Wm., Can. Ent., vol. LVI, No. 3, p. 61; 1924.

This bright orange-marked little species resembles *E. kanwakae* Rob., but may be easily separated by the absence of most dark marking on abdomen, by posterior point of style as long as foot and without extra process in pygofer hook.

Genitalia. Pygofer hook typical U-shaped. Foot of style small; heel prominent; base curved, anterior point fairly long and thick; posterior point more than half as long as base, very thin and sharp. Aedeagus in ventral view truncate with a small projection at either corner, processes small, about as long as shaft, diverging to about width of shaft.

Specimens at hand from Douglas, Anderson, and Cherokee counties, Kansas, and Ramsey county, Minnesota.

12. *Erythroneura elegans* McAtee

Erythroneura comes var. *elegans* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 305; 1920.

General ground color yellowish white marked with orange or reddish-brown. Vertex with inverted U-shaped mark, arms enlarged at base, continued on pronotum as very heavy Y-shaped mark. Pronotum with an additional vitta back of each eye. Scutellum mostly dark reddish with lighter spot near apex. Elytra with six light areas, two more or less pentagonal mesal spots, smaller at tip of scutellum, other on apex of clavus, one angular dash from costa to claval suture between humerus and plaque and the other between the plaque and cross veins. Cross veins pink or red. Apical cells more or less infuscated, darker spot in costal plaque and apex of cell R_3. Mesosternum dark.

Genitalia. Pygofer hook U-shaped, inner process about one-fourth longer than outer. Foot of style small; heel prominent; base almost straight; anterior point two thirds as long as width of foot at narrowest place; posterior point slightly shorter, both sharp. Aedeagus in dorsoventral view more or less three pronged, processes about as long as shaft, almost parallel and about straight in lateral view.

Redescribed from the male holotype, Plummer's Island, Md., Jan. 11, 1914; W. L. McAtee. In his collection.

This species externally resembles *E. ziczac* Walsh, but may be separated from that species by the lack of an orange spot on apex of clavus and by the colored zigzag vitta of dorsum being of varied widths.

A beautiful species distributed throughout most of the United States.

13. *Erythroneura cancellata* McAtee

Erythroneura comes var. *cancellata* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p 320; 1920.

This is one of the most striking species in the genus with its beautiful lighter colored diamond-shaped spot occupying a large portion of dorsum of elytra, surrounded by the darker wine color.

Genitalia. Pygofer with typical *comes* U-shaped hook. Style with small foot; base curved; anterior point short and heavy; pos-

terior point short and sharp. Aedeagus in lateral view almost circular with processes diverging one third distance before tip.

Although not as plentiful as some, specimens of this species are not uncommon in the states east of the Rocky Mountains.

This species was described from 2 females from Plummer's Island, Md., one designated type, the other paratype and in the collection of W. L. McAtee. A male from Anderson county, Kansas, described above is therefore designated allotype.

Miss Dorothy M. Johnson's statement "female (holotype) Adams county, IX-1-31, E. P. B." Ohio State Univ. Bul. 31 Vol. 39, 1935, p. 109, is evidently an error.

14. *Erythroncura aclys* McAtee

Erythroneura aclys McAtee, W. L., Trans. Am. Ent. Soc., vol. XLVI, p. 290, 1920.

Original description. "Base of fourth apical cell angulate, vertex rather pointed; color pattern consisting of a broad, brown to black stripe extending whole length of insect, margined by pale yellow. The dorsal stripe nearly black on scutellum and anterior parts sharply cut off from a pale yellow margin about the width of eye; on tegmina the stripe is smoky brown, greatly expanded and irregularly set off from the pale yellow costal margin, percurrent to second apical cell which is about the width of costal plaque; the latter has a slight opaque whitish coating, is margined interiorly and anteriorly by reddish, and underlaid posteriorly by blackish; there are touches of red upon apex of clavus and first cross vein and more or less hyaline spots at extremities of apical third of clavus, on the corium nearby and in middle of fourth apical cell. The legs, pleura and face vary from flesh-color to pale yellow, and the venter is pale yellow with a median series of slaty spots, the posterior ones extending entirely across last abdominal segment and across base of genitalia; dorsum slaty."

Genitalia. Pygofer hook U-shaped, outer process about two thirds as long as inner. Foot of style medium; heel small; base straight; anterior point almost as long as width of foot; posterior point about as long as base. Aedeagus in dorsoventral view, broad, almost quadrangular, tube projecting, lateral margins with long sharp projecting apices.

This is a very common species throughout the United States east of the Rocky Mountains.

15. *Erythroneura prosata* Johnson

Erythroneura infuscata var. *prosata* Johnson, Dorothy M., Ohio Biol. Survey Bul. 31, p. 108, 1935.

Resembling *E. ziczac* Walsh, but with much more dark coloring on vertex pronotum and elytra, by posterior point of style being as long as base of foot, sharp, and by processes diverging radically on outer third.

General color, blood-brown. Vertex sometimes with red inverted V evident, often with median longitudinal stripe and two lateral spots light. Thorax also with Y-shaped median and lateral red dashes more or less evident. Scutellum usually with a median longitudinal light rectangular spot, often spool-shaped. Clavus with small median light spot on mesal margin, another smaller spot slightly outside claval suture and toward cross veins and an indication of a light spot on apex, the three forming a semi-circle. Corium with oblique oblong area anterior to costal plaque; costal plaque, except dark oblique spot in outer end and two spots beyond plaque, light. Light areas usually bounded with red. Cross veins lighter, apical cells dark with clear areas sometimes present. Mesosternum dark.

Genitalia. Pygofer hook U-shaped, outer process about half as long as inner. Foot of style medium; heel prominent; base straight; anterior point half as long as width of foot, sharp; posterior point as long as base, straight. Aedeagus in dorsoventral view broad, tube protruding, shaft sharply constricted on basal half, processes sharply diverging on outer half.

Named from three specimens from Pickaway county, and Coal Grove, Ohio. Numerous specimens are at hand from Wabash county, Illinois.

16. *Erythroneura ziczac* Walsh

Erythroneura ziczac Walsh, B. D., Prairie Farmer 10, No. 10, 1862, p. 149.

The original description is as follows: "Pale yellowish. Front of head in a right angle, the apex rounded. Eyes dusky; ocelli pale; vertex with two pale sanguineous vittae, generally subobsolete. Thorax blood-brown, yellowish in front, often with a yellowish vitta; scutel blood-brown with a yellowish vitta, occasionally entirely yellowish. Abdomen often blood-brown, except at base and tip; tip of ovipositor and of tarsi dusky. Elytra pale yellowish; on the middle of the costa an oblique rhomboidal black spot, on the

costal tip a black dot, and on the interior margin, forming a triangle with the other two spots, a black spot; a blood-brown, irregular broad strip, covering the humerus, thence running to the interior margin, thence in a zigzag direction to the rhomboidal spot, thence to the spot on the interior margin, thence not quite attaining the terminal dot. Wings hyaline; tips of costal veins, often dusky. Length to tip of wings a little over one tenth inch. Occurs abundantly on the grapevine."

A careful study of Walsh's description with specimens at hand reveals the fact that what has commonly been called *E. ziczac* is not true *ziczac* at all but the light form of this species which I am describing as *E. ziczac* var. *walshi*. True *E. ziczac* is much darker throughout with all of the pronotum "blood-brown" except a small rectangular area on anterior margin.

Since Walsh's types are lost a male and female from Wabash county, Illinois, March 31, 1929, are here selected as neotypes. Other specimens are at hand from Illinois, Ohio, Indiana, New York, and Vineland, Ontario. (Plate XIX, fig. 16.)

Erythroneura ziczac var. *walshi* n. var.

Resembling *E. ziczac* Walsh but with lighter coloring, narrower markings, and pronotum never dark colored on basal two thirds.

Color. General ground color yellowish white, markings red to dusky. Vertex with inverted V-shaped red mark, sometimes closed basally. Pronotum with Y-shaped and lateral bands red to dusky. Scutellum with basal angles yellow bordered with red, apex red. Tegmen with red to dusky zigzag stripe arising on humerus, ending at base of cell M_4. Red spot on apex of clavus. Cross vein red. Apical cells more or less dusky.

Holotype male Jefferson county, Nebraska, Beamer and Hungerford. Allotype female, Reno county, Kansas, August 13, 1924, Beamer and Lawson, and the following paratypes, 10 males and 6 females same data as allotype; 7 males and 11 females, Douglas county, Kansas; 5 males and 2 females, Atchison county, Kansas; 3 males and 6 females, Jordan, Ontario, Aug. 1922, Wm. Robinson; 3 males and 3 females, Vineland, Ontario, Wm. Robinson; 1 female Clayton county, Iowa, 1930, R. H. Beamer.

Examination of the genitalia of many specimens failed to reveal any characteristic differences between this and *E. ziczac* Walsh. They are, however, easily distinquished by the absence of the dark coloring on the posterior two thirds of the pronotum.

17. *Erythroneura elegantula* Osborn

Erythroneura elegantula Osborn, Herbert, An. Carnegie Mus., Pitts., 1928, p. 289.

Resembling *Erythroneura coloradensis* (Gill.), but with much more pointed vertex, widely separated arms of the inverted V of the vertex, rounded tip of the aedeagus in ventral view and posterior point of style being longer than anterior.

General ground color ivory with principal markings red or orange. Vertex with narrow-sided inverted V with arms widely separated, sometimes touching eyes. Pronotum with median Y-shaped mark sometimes not touching either margin and a dash back of each eye. Scutellum usually with basal angles black but often just yellow, apex usually red or orange. Clavus with typical anchor-shaped spot and smaller one on apex. Corium with dash on base, an irregular sided vittae surrounding costal plaque, extending to claval suture before apex and usually fading out about base of cell M_4. Black dash in posterior end of costal plaque, small round black spot in apex of cell R_3 and larger one in base of cell R_4. Abdomen dark, especially the dorsum, which often gives the elytra a darker appearance.

Genitalia. Pygofer hook U-shaped, one arm much shorter than other. Style with small foot; heel small but prominent, base curved, anterior point about twice as wide as posterior and about as long, posterior point sharper, about as long as base. Aedeagus in ventral view more or less globular, somewhat pointed at apex, usual pair of processes rather short and almost parallel.

Redescribed from the types in Osborn Collection labeled "Canal Zone, Panama."

This is one of the commonest and most destructive species found on grape in California. Specimens are also at hand from Colorado and Kansas.

18. *Erythroneura coloradensis* (Gill.)

Typhlocyba vitifex var. *coloradensis* Gillette, C. P., Bul. 19, Colo. Agr. Exp. Sta., May, 1892, p. 16, fig. 8.

Redescribed from the types in U. S. Nat. Mus. General ground color semihyaline to yellowish white. Markings orange. Vertex with inverted orange V not touching eyes. Pronotum with median V, heavy basally, arms short; lateral dashes back of eyes, not reaching posterior margin. Scutellum with basal angles black surrounded by yellow tip tinged with orange. Clavus with heavy basal anchor spot and another at tip. Corium with oblique dash near base and an irregular sided vitta arising on costa at anterior end of costal

plaque, almost surrounding it, touching claval suture near apex of anchor spot, following vein Cu to end in cross veins. Black spot in posterior end of costal plaque, another in apex of cell R_3, a third in base of cell M_4, cross veins pink, apex of elytra more or less infuscated. Venter stramineous, face marked with pink, mesosternum and abdomen more or less infuscated.

Genitalia. Style with short foot; heel inconspicuous; anterior point longer than foot, wider than posterior; posterior point shorter and sharper almost as long as base. Tip of aedeagus in dorsoventral view truncate, processes reaching tip, slightly diverging. Pygofer hook typically U-shaped.

Hololectotype male No. 3447, U. S. Nat. Mus., allolectotype, female, No. 3447, U. S. Nat. Mus.

This is a very common species in the central United States on grape and Virginia creeper. It is easily separated from other species by the blunt vertex and the two round black spots in basal angle of scutellum.

19. *Erythroneura palimpsesta* McAtee

Erythroneura comes var. *palimpsesta* McAtee, W. L., Ill. Nat. Hist. Survey, Bul., vol. XV, Art. II, p. 43, 1924.

Original description. "Like *E. comes* var. *vitifex* Fitch except that the red vitta on anterior half of clavus and the adjacent short vitta on corium are overlaid or replaced by black; the lateral vittae on pronotum and the sides of the scutellum also may be dusky to black, and the oblique dusky band of antennae, pro- and mesopleuro, base and apex of genitalia and broad vittae on dorsum of abdomen also may be dusky to black. Length, 3 mm.

"Holotype male, and two females, one of which is allotype, Forest City, Ill., April 3, 1917."

This species is easily separated from all others, as McAtee points out by the black coloring overlying the red in the basal anchor-shaped mark of the clavus as well as some of the spots of the corium. The red mark of the vertex differs too in that it is oval or sometimes almost round.

Genitalia. Pygofer hook U-shaped, outer process about one fourth shorter than inner. Foot of style large; heel prominent, projecting; base curved; anterior point short, blunt; posterior point longer than foot, narrow, almost parallel sided. Aedeagus in dorsoventral view bell-shaped, apex truncate, processes as long as shaft diverging on outer half.

This species is quite rare. Specimens are at hand from Illinois and Kansas. Types in the Collection of the Illinois Natural History Survey, Urbana, Ill.

20. *Erythroneura pontifex* McAtee

Erythroneura comes var. *pontifex* McAtee, W. L., Ill. Nat. Hist. Sur. Bul., vol. 16, p. 136, 1926.

Erythroneura breakeyi Johnson, Dorothy M., Ohio Jr. Sci., No. 4, p. 261, 1934.

Original description. "Like *E. comes* var. *reflecta* McAtee (Bul. Ill. State Nat. Hist. Sur., 15, Art. II, April, 1924, p. 43, Md., Va., Ill., Ia., Kan.), but with two black finger-shaped vittae on vertex overlying an inverted heart-shaped brownish marking; a marking somewhat similar to latter can be seen through the disk of pronotum. Length, 3 mm.

Holotype female, Dubois, Ill., May 24, 1917. Deposited in the collection of the Illinois State Natural History Survey."

General ground color white, markings reddish fumose to black. Vertex with inverted V with arms usually connected basally, mostly black. Pronotum with infuscated red Y and a short red dash back of each eye. Scutellum with basal angles yellow margined with red, apex red. Zigzag markings of elytra more or less infuscated. Cross veins red. Apical cells more or less fumose.

Genitalia. Pygofer hook U-shaped, outer process about half as long as inner. Foot of style large; heel prominent; base almost straight; anterior point very short; posterior point longer than foot, sides almost parallel. Aedeagus in dorsoventral view with very broad lateral wings, canal protruding, processes longer than shaft, bent almost at right angles out on outer third. Processes in lateral view without abrupt narrowing as in *E. reflecta* McAtee.

Since this species was named from a female holotype, the male described above, Wabash county, Illinois, March 31, 1929, is designated allotype.

This species resembles *E. reflecta* McAtee, but is easily separated from that species by the black on the red inverted V of the vertex.

Not a very common species, but found throughout the eastern half of the United States.

21. *Erythroneura kanwakae* Robinson

Erythroneura kanwakae Robinson, Wm., Can. Ent., vol. LVI, No. 12, p. 292; 1924.

This species closely resembles *E. fraxa* Rob., but may be separated from it by being smaller with head much sharper pointed,

with much more dark coloring on venter of abdomen, aedeagus almost rectangular in dorsal view, posterior point very short and pygofer hook with three processes instead of two.

Genitalia. Pygofer hook U-shaped with an additional process somewhat longer than shorter process and slightly shorter than the longest. This character is unique in this species. Foot of style very short; base curved; both points short and not very sharp. Aedeagus about rectangular in ventral view, sides almost parallel, processes present, about as long as shaft, slightly divergent at tip.

Specimens are at hand from Kansas, Nebraska, and Iowa.

22. *Erythroneura anfracta* Beamer

Erythroneura anfracta Beamer, R. H., Ann. Ent. Soc. Am., vol. XXII, p. 123; 1929.

Most easily confused with *E. vitifex* Fitch, from which it may be separated by the fumose coloring in the red markings, by each process of aedeagus having a distinct spiral near base, sometimes incomplete and by aedeagus in ventral view having narrower lateral processes.

Common in Arizona on grape.

23. *Erythroneura vitifex* Fitch

Erythroneura vitifex Fitch, Asa. Rep., N. Y. Ag. Soc. 16, pp. 392-393, 1856.

Original description, in part: "Yellowish white, the wing covers with oblique confluent blood red bands and a short oblique black line on the middle of their outer margin; thorax commonly with three red stripes, the middle one forked anteriorly and confluent with two red stripes on the middle of their outer margin; thorax commonly with three red stripes, the middle one forked anteriorly and confluent with two red stripes on the crown of the head. Length, 0.12. When the wing covers are closed they appear red with a cream-colored spot shaped like a heart anteriorly, and on their middle a large diamond-shaped spot with a small red spot in its center. It resembles an individual of the *comes* of Say, having the red spots so enlarged as to all run together, but the marks upon the thorax are totally different from those of that species . . ."

General ground color yellowish white marked with orange. Vertex with orange inverted V, continued across pronotum as Y. Pronotum with an additional stripe on lateral margin. Scutellum with basal angles and tip orange. Elytra with rather broad zigzag vitta from humerus to cross veins, more or less surrounding costal plaque. An additional oblique dash on costa near base. Cross

veins red. Apical cells more or less infuscated. Black dash in posterior end of costal plaque, black spot in base of cell M_4 and apex of cell R_3. Mesosternum black.

Genitalia. Pygofer hook U-shaped outer process about one third as long as inner. Foot of style small; heel not prominent; base more or less curved; anterior point broad, about as long as foot in narrowest place; posterior point short and sharp, not more than half as long as anterior. Aedeagus in dorsoventral view heart-shaped, processes longer than shaft, often diverging.

Since the types of this species are lost the male, Vineland, Ontario, Aug., 1922, described above is designated neotype.

E. vitifex Fitch closely resembles *E. beameri* Rob., but may be separated by the dark mesosternum and by the short posterior point of foot of style.

This is a damaging hopper on grape throughout the eastern half of North America.

24. *Erythroneura caetra* McAtee

Erythroneura ligata var. *caetra* McAtee, W. L., Proc. Biol. Soc., Wash., vol. 37, p. 133, Dec., 1924.

E. caetra McA. resembles *E. Rosa* Rob. quite closely, but occurs west of the Rocky Mountains, the color of pronotum usually is not evenly distributed, and outer process of pygofer hook is about one third as long as inner.

General ground color semihyaline to yellowish white with dusky and reddish markings. Vertex yellowish with some darker shading, nothing very definite. Pronotum with semblance of U-shaped darker mark; large angular brown spots tinged with red back of each eye. Scutellum with tip orange, basal angles dark brown. Clavi with usual anchor-shaped basal mark very large, tip tinged with pink, remainder dusky, elongated pink spot on tip. Coria with irregular-sided pink mark beginning opposite pink tip of anchor-shaped mark on clavi, reaching to plaque, following around it almost to costa at its posterior end, ending on Cu before base at cell M_4. Black or smoky stripe running almost length of R_3, crossing base of M_2 and ending in darker spot in base of M_4. Black spot in posterior end of costal plaque. Tip of front with black spot, mesosternum shining black, dorsum of abdomen and most of ventral sclerites black.

Genitalia. Pygofer hook semi-U-shaped, the outer process much shorter than in typical *comes* groups, about one fifth as long as inner. Foot of style rather small; heel medium; anterior point long, sharp,

less than right angle; posterior point very short, obtuse angled. Aedeagus in ventral view flattened, almost parallel sided, constricted just before tip, ventral processes usually short, almost straight, not reaching nearly to tip. In lateral view shaft almost straight, broad, almost half as wide as long, evenly hollowed out at tip, ventrally notched.

A male, described above, La Fayette, Cal., July 14, 1933, Mrs. R. H. Beamer, is here designated allotype. The species was described from a single female in the collection of E. D. Ball. Other specimens are at hand from Idaho, Oregon, and British Columbia. It is commonly found on willow. According to Doctor Ball's notes this is the host of the type.

It is possible this is a synonym of *E. rosa* Rob. as they are very close indeed, but since the ranges are different and there seems to be some slight morphological differences I prefer to consider them distinct.

25. *Erythroneura rosa* Robinson

Erythroneura rosa Robinson, Wm., Can. Ent., vol. LVI, No. 3, p. 58, March, 1924.
Erythroneura mallochi McAtee, W. L., Bul. Ill. Nat. Hist. Sur., vol. XV, Art. II, p. 41, April, 1924.

This species is quite variable in coloring. It may usually be distinguished from *E. caetra* McA. by having markings of the clavus evenly distributed, by having a broader aedeagus in ventral view and the short point of pygofer hook almost absent.

Genitalia. Pygofer hook sickle-shaped, outer point very short. Foot of style short; heel almost absent; anterior point about half as long as width of toe, sharp; posterior point almost absent. Aedeagus in dorsoventral view rectangular, lateral margins almost parallel, processes shorter than shaft, diverging sharply near tip.

This is a very common species on willow in the United States east of the Rocky Mountains.

Erythroneura rosa var. *repetita* McAtee

Erythroneura repetita McAtee, W. L., Bul. Ill. Nat. Hist. Survey, vol. XVI, Art. III, p. 131, Aug. 10, 1926.

Specimens of this variety may easily be separated from those of *E. rosa* Rob. by having the color of the dorsum in the form of three crossbands. The anterior crossband is usually darker while the middle one is often quite red as in *E. vitis* (Harris). Numerous specimens of this variety were swept from willow in Scott county, Arkansas, August, 1928, along with a lot of other variations, including typical *E. rosa* Rob.

26. *Erythroneura reflecta* McAtee

Erythroneura comes var. *reflecta* McAtee, W. L., Ill. Nat. Hist. Sur. Bul., vol. 15, p. 43, April, 1924.

Erythroneura portea Robinson, Wm., Can. Ent., vol. 56, No. 7, p. 154, 1924.

Original description. "Much like *E. comes* var. *rubra* Gillette in connection with which it was mentioned in my key, but the pale markings are more extensive, and the red ones, instead of being a solid jasper-red as in that form, are dilute bluish-red with carmine edgings; the fact that all of the red vittae are of this compound character gives the variety the appearance of having the most complex pattern of any of the *comes* varieties.

"Type female, Plummer's Island, Md., etc."

General ground color yellowish-white, with the following markings: Vertex with inverted V-shaped, reddish vitta. Pronotum with a slaty-brown area on disk with two reddish arms projecting forward to meet the vitta on vertex; a lateral vitta behind each eye. Scutellum with basal angles yellow surrounded with red, apex yellow. Tegmina, a reddish vitta arising in base of clavus, soon broadening and proceeding across corium to costal plaque, where it becomes as wide as length of plaque, then proceeding inward and dividing into two arms, one of which touches tip of clavus and the other the base of cell M_4. This vitta is sometimes paler within and margined in dark red; sometimes bluish within dark red margin; tip of clavus pale red. Cross veins crimson, apical cells more or less infuscated.

Genitalia. Pygofer hook U-shaped, outer process about half as long as inner. Foot of style large; heel prominent; base straight; anterior point short, slightly less than a right angle; posterior point longer than foot, narrow, almost parallel sided. Aedeagus in dorsoventral view broad, tube slightly projecting, processes longer than shaft, diverging sharply on outer half, in lateral view contracting sharply near middle.

This is a very common species throughout the eastern half of the United States and Canada. It is quite variable in color. Especially is the summer form different from the overwintering. It is often quite light on anterior half while the elytra have the markings concentrated into a large circular area, which is often bright red. The contracted process of the aedeagus seen in lateral view separates this species from all others.

27. *Erythroneura prima* n. sp.

Resembling *E. rubra* (Gill.), but color on vertex in two longitudinal vitta, color on elytra in even sided zigzag stripes, pygofer hook

with three processes, and processes of aedeagus with recurved lateral hooks.

General ground color yellowish-white marked with brownish-red. Vertex with two longitudinal narrow vittae, in winter specimens this may be one bar. Pronotum with heavy median Y-shaped spot with large irregular-shaped spot back of each eye. Scutellum with basal angles reddish. Clavus reddish-brown except small oval spot at tip of scutellum and another smaller one two thirds distance to apex. Corium with zigzag vitta arising on costa at anterior end of costal plaque, widening to broadly touch claval suture near apex of anchor spot and ending in cross veins near base of cell M_4. Cross veins bright red. Apical cells more or less dusky. Venter dark.

Genitalia. Pygofer hook U-shaped with three processes in graduated series, outer the shortest. Style of foot small; heel evident; base curved; anterior point about one third as long as toe is wide, about as wide at base as length; posterior point just about a right angle, scarcely evident. Aedeagus in dorsoventral view spatulate; processes shorter than shaft, apices sharp, diverging with recurved hook on outer margin.

Holotype, male, allotype female, 1 male, and 6 female paratypes, Bretton Woods, N. H., August 31, 1934, R. H. Beamer. In Snow Entomological Collection.

28. *Erythroneura nudata* McAtee

Erythroneura comes var. *nudata* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 316, 1920.

Erythroneura attenuata Johnson, Dorothy M., Ohio Jr. Sci., vol. XXXIV, No. 4, July, 1934.

Original description. "Color of scutellum and anterior parts pale yellowish with irregular pellucid areas, instead of the color vittae and spots usually present in other varieties; tegmina whitish hyaline, apical cells somewhat fumose; costal plaque rather opaque white, an oblique black streak across it posteriorly, and black dots in bases of fourth apical, and apices of second apical cells. Placed as a variety of *comes* because of the presence of dark spots in apices of second apical cells, altho so far as coloration goes no intergrading specimens have been seen."

This species was described from teneral specimens and has only been recognizable through the internal male genitalia.

General ground color yellowish-white marked with red or orange. Vertex with inverted V quite narrow, continued across pronotum as a thin Y. Lateral margins of pronotum with a narrow vitta.

Scutellum with basal angles yellow, often bordered with red, tip orange. Elytra with typical orange markings of *E. comes*. Apical cells more or less infuscated. Black line in posterior end of costal plaque, spot in base of cell M_4 and apex of cell R_3.

Genitalia. Pygofer hook U-shaped, inner process more than twice as long as outer. Foot of style large; heel medium; base straight; anterior point about as long as shortest width of foot; posterior point much longer than foot, about as wide at base as foot at narrowest place. Aedeagus in dorsoventral view quite broad, bell-shaped, processes about as long as shaft, heavy, slightly divergent.

This species is close to *E. beameri* Rob. but may be separated from it by the broad bell-shaped aedeagus and heavier, straighter processes.

A common species throughout the eastern half of the United States.

29. *Erythroneura beameri* Robinson

Erythroneura beameri Robinson, Wm., Can. Ent., vol. LVI, No. 3, p. 61; 1924.

Resembles *Erythroneura vitifex* Fitch, but may be separated by its light mesosternum, and by the very long posterior point of style.

A very common species in the United States east of the Rocky Mountains.

30. *Erythroneura vaga* Johnson

Erythroneura vage Johnson, Dorothy M., Ohio Jr. Sci., No. 4, p. 260, 1934.

This species is close to *E. comes* (Say) or *E. beameri* Rob., but may usually be separated from those species by the extra lateral orange marks on the vertex and quite easily by the long slender shaft of aedeagus with bifid tip.

Named originally from two specimens. Numerous specimens are at hand from Louisiana, Arkansas, Illinois and Kansas.

Unlike the drawing of the type most specimens have an additional spine beneath the base of the aedeagal shaft.

31. *Erythroneura ancora* Beamer

Erythroneura ancora Beamer, R. H., Ann. Ent. Soc. Am., vol. XXII, p. 122; 1929.

This species is near *E. omaska* Rob., but may be separated by color on vertex confined to inverted V, dark marking near cross veins confined to black spot in base of cell M_4 and aedeagus without divided tip. It has not been taken since the type series from Culberson county, Texas.

32. *Erythroneura omaska* Robinson

Erythroneura omaska Robinson, Wm., Can. Ent., vol. LVI, No. 3, p. 61; 1924.

This species is often milky white as in *E. delicata* McAtee and may be confused with this species, but is usually easily separated by the broader pink or orange markings.

Genitalia. Pygofer hook U-shaped, both arms practically same size. Foot of style small; heel prominent; base curved; anterior point almost as long as width of foot at narrowest place; posterior point about half as long. Aedeagus long and slender, bifid on outer fifth, pair of slender lateral processes near middle, in lateral view bent dorsally on apical fifth.

This is a very common species throughout the United States east of the Rocky Mountains. Specimens are at hand from Kansas, Illinois, Arkansas and Louisiana.

33. *Erythroneura delicata* McAtee

Erythroneura comes var. *delicata* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 317, 1920.

Erythroneura lacta Robinson, Wm., Can. Ent., LVI, No. 3, p. 62; 1924.

Original description. "Ground color milky white, with red color markings of the *comes* type, the spots usually small and well separated."

This beautiful species is easily distinguished by its milk-white general color with delicate pink markings. Poorly marked specimens of *E. omaska* Rob. might be confused with it but may be separated by the male genitalia and much broader pink markings.

Vertex with thin inverted pink U-shaped mark with curving sides. Pronotum with narrow median Y-shaped spot and small dash on each lateral margin pink. Scutellum with basal angles yellow, tip pink. Clavus with anchor-shaped basal spot broken into a small basal dash and larger apical portion, another small dash near apex. Corium with oblique dash near base, a vitta arising on costa at anterior end of costal plaque, following its inner margin with offshoot to meet claval suture near its middle, angling to end in base of cell M_4. Cross veins pink. Apical cells more or less infuscated. Venter yellowish white with mesosternum and last ventral segment of male fuscous.

Genitalia. Pygofer hook U-shaped, inner arm more slender and about one third longer than outer. Foot of style small; heel small; base curved; anterior point medium sized, outer face convex; posterior point very small, one third as wide as anterior and very short

and sharp. Aedeagus in dorsoventral view, for the most part broad, canal produced in middle, lateral margins with sharp, forward projections about one third distance from apex, usual processes almost parallel and not reaching to apex.

Holotype female, Plummer's Island, Md., July 26, 1914; W. L. McAtee. Since no allotype was made a male paratype, described above, Plummer's Island, Md., Oct. 26, 1913, W. L. McAtee, is so designated.

Types in collection of W. L. McAtee.

This beautiful milk-white species is very common in the United States east of the Rocky Mountains.

Erythroneura delicata var. *accepta* McAtee

Erythroneura comes var. *accepta* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 317; 1920.

Erythroneura scripta Robinson, Wm., Can. Ent., vol. LVI, No. 12, p. 290; 1924.

Erythroneura tudella Robinson, Wm., Can. Ent., vol. LVI, No. 12, p. 291; 1924.

Like *Erythroneura delicata* McAtee, but with a dark mark in the orange spot near middle of clavus. It occurs over the same range but is not so common.

34. *Erythroneura corni* Robinson

Erythroneura corni Robinson, Wm., Can. Ent., Vol. LVI, No. 3, p. 60; March 1924.

Erythroneura ornata Osborn, H., Ohio Biol. Surv. Bul., XIV, p. 364, 1928.

This is the common species on *cornus* in central and southern United States. It may usually be distinguished by the red marks of vertex and pronotum being suffused with fuscous and by the rather indefiniteness of the markings in general. The slender aedeagus in ventral view, the more definite points on the foot of style and the forks of the pygofer hook touching or almost touching are also characteristic.

A very common species east of Rocky Mountains.

35. *Erythroneura bidens* McAtee

Erythroneura comes var. *bidens* McAtee, W. L., Fla. Ent., vol. VIII, p. 39; December, 1924.

Erythroneura comes var. *suffusa* McAtee, W. L., Fla. Ent., vol. VIII, December 24, 1924, p. 39.

Original description. "Like *E. comes* var. *rubra* Gillette, except that the upper surface of pronotum save a semielliptical space on each anterior angle, and a semicircular spot in middle of front margin, is black. Length, 2.8 mm. Holotype male, Virginia near Stubblefield Fall, on *Pinus virginiana,* October 23, 1921, J. R. Malloch."

Specimens from Glen Echo, Md., and others near Washington, D. C., collected by P. W. Oman, on comparison with the holotype, a female instead of a male, as the original description states, are unquestionably this species.

General ground color semihyaline to whitish with orange and fuscous marks. Vertex red, with a pair of mesal longitudinal white vittae and an additional row of white spots on each side. Pronotum usually fuscous, but sometimes orange except three white spots on anterior margin. Scutellum orange to fuscous. Clavus with anchor-shaped mark and another elongated area before tip orange. Corium with irregular-sided vitta on costa, surrounding costal plaque, approaching claval suture at three points and touching cross veins on costal and mesal margin. Apical cells dark. Venter dark. Legs lighter.

Genitalia. Pygofer hook large, long side with tip enlarged and bent out at about right angles, about twice as long as short side. Style with medium foot, medium heel and rather short anterior and posterior point. Aedeagus with shaft narrow, rather long, parallel-sided, in lateral view bent dorsally on outer third.

This species is distinguished from the others found on *Cornus* sp. by the thickened outwardly angled long point of pygofer hook. The dark pronotum will distinguish most specimens of *bidens*, but I have a few from Illinois that lack this color.

36. *Erythroneura rubrella* McAtee

Erythroneura comes var. *rubrella* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 316, Aug. 26, 1920.

General ground color milky white with the dark body color visible; markings bright red. Vertex red except two median longitudinal vittae separated by narrow red line, two round spots near each eye and marginal band around tip of vertex which are yellowish white. Pronotum with broad Y-shaped median mark and marginal band red. Scutellum with basal angles yellow, remainder red except inverted white T-shaped mark. Clavus with usual red basal anchor-shaped mark and another elongated spot near apex. Corium with red irregular sided vittae arising near base more or less surrounding plaque, ending in cross veins near tip of Cu. Cross veins slightly brighter red. Apical cells more or less infuscated. Black spot in posterior end of costal plaque. Venter dark.

Genitalia. Pygofer hook double; inner fork heavy at base, twice as long as outer, curved out on outer half at right angles to basal; outer fork narrower, leaving base at an angle, forming gentle curve

toward inner fork. Style with median foot; toe broad; anterior and posterior points usually small but not so well marked as in *E. corni* Rob. Aedeagus in dorsal view short and thick, half as broad as long, evenly narrowed on outer half to sharp tip, quite spinose; in lateral view short and thick, tip slightly curved dorsally.

Type dissected and numerous specimens studied from British Columbia, Arkansas, Mississippi, Illinois.

This is structurally very distinct from all the other forms. The very broad aedeagus is quite different from the long slender structure found in the others.

37. *Erythroneura ontari* Robinson

Erythroneura ontari Robinson, Wm., Can. Ent., vol. LVI, p. 60, March, 1924.

This species resembles *E. corni* Rob., but may usually be distinguished by the narrower markings on vertex and pronotum which lack the fuscous suffusion. The pronotal Y-shaped mark is usually more evident. The pygofer hook will separate it from the other species except *E. rubrella,* from which it can be distinguished by the very narrow aedeagus in dorsal view. This is a widespread species both in the United States and Canada.

38. *Erythroneura aza* Robinson

Erythroneura aza Robinson, Wm., Can. Ent., vol. 56, No. 12, p. 291; 1924.

Original description. "Ground color of vertex, pronotum and scutellum ivory, of tegmina white, with following marks in orange; vertex, a narrow median inverted U-shaped vitta; pronotum, a broad median Y-shaped vitta and a broad lateral vitta behind each eye; scutellum, a broad spot in each basal angle and a small spot at tip. Tegmina lightly washed with orange throughout except at inner basal angle of clavus and in base of corium, where the orange is deepened to nearly red. Cross veins and adjacent parts of longitudinal veins crimson. A black streak caudad of costal plaque; apical cells whitish at base, remainder dusky, especially near the base. A black spot in apex of cells R_3 and base of cell M_4."

This species resembles *E. delicata* McAtee, but may be separated from that species by a more hyaline appearance, the red or orange markings larger and heavier and the posterior point of style half as long as base.

Genitalia. Pygofer hook typically U-shaped. Foot of style medium sized; heel medium; base straight; anterior point about as long as width of foot at narrowest place, outer face convex, rather wide at base; posterior point sharp and narrow, about half as long

as base. Aedeagus in dorsoventral view almost three pronged, two laterals almost retrorse at tip.

Known from the types from Lawrence, Kansas, and three additional male specimens, one each from Douglas county and Leavenworth county, Kansas, and one from Natchitoches, La.

39. *Erythroneura rubra* (Gill)

Typhlocyba comes var. *rubra* Gillette, C. P., Am. Typholocybinae, 1898, p. 764.
Erythroneura irrorata Robinson, Wm., Can. Ent., vol. LVI, No. 7, p. 154; 1924.

This red-marked species resembles the dogwood series and is often found confused with them in collections. It may easily be separated from them by always having the mesal longitudinal line of vertex light colored instead of dark as in the dogwood series.

Widely distributed throughout the eastern two thirds of the United States and Canada.

Type in the United States National Museum.

40. *Erythroneura festiva* n. sp.

Resembling *E. rubra* Gill., but can be separated by the smaller size, the much narrower color marks, by anterior point of style as long as foot and aedeagus in dorsoventral view quadrangular, tube not protruding.

Ground color semihyaline to whitish with coppery colored marks more or less clouded with fumose. Vertex copper colored except mesal, longitudinal keyhole-shaped spot, circular spot either side of this near base and a narrow spot on lateral margin between apex and eye. Pronotum with median Y-shaped spot with very short base, and two lateral stripes coppery. Scutellum red, except basal angles yellow and mesal white bar with end knobbed near apex; clavus with basal anchor-shaped mark and apical spot red. Corium with red basal dash and irregular-sided mark surrounding costal plaque, touching claval suture in two places and ending at cross veins near base of cell M_4. Costal plaque with black basal dash. Apical cells more or less infuscated. Veins whitish. Venter quite dark.

Genitalia. Foot of style small; posterior point as long as base; anterior short and sharp. Aedeagus in ventral view almost rectangular, apically incised either side of orifice with pair of ventral processes extending slightly beyond apex. Pygofer hook of usual *comes* type.

Holotype male and allotype female, White county, Illinois, March 31, 1929, R. H. Beamer.

Paratypes as follows: 11 males and 3 females, Colfax, La., December 23, 1931, R. H. Beamer; 1 male and 1 female, Clearwater, La., December 21, 1931, R. H. Beamer; 4 males and 2 females, Cherokee county, Kansas, December 17, 1930, R. H. Beamer; 1, Fouke, Ark., December 21, 1931, R. H. Beamer; 1 female, Coal Creek, Tenn., August 27, 1930, R. H. Beamer; numerous males and females from White, Clay, and Gallatin counties, Illinois, collected in March, 1929, by P. W. Oman and R. H. Beamer.

41. *Erythroneura compta* McAtee

Erythroneura comes var. *compta* McAtee, W. L., Trans. Am. Ent. Soc., XLVI, p. 318; 1920.

Erythroneura cherokee Robinson, Wm., Canl. Ent., vol. LVI, p. 154; 1924.

Erythroneura nigroscuta Johnson, Dorothy M., Ohio Jr. of Sci., vol. XXXIV, No. 4, p. 258; 1934.

Resembling *E. delicata* var. *accepta* McAtee, but pink markings heavier, white background not so striking, scutellum usually with dark markings, posterior point of style longer than foot and processes of aedeagus bifid.

General ground color yellowish-white. Red inverted V of vertex rather narrow, branched even with anterior edge of eye, encircling light spots between eyes and main arms of V, continued across pronotum to unite on posterior margin. Pronotum with an additional red strip on lateral margin. Scutellum mostly dark, extreme lateral angles and spot near center light. Clavus with usual anchor-shaped spot at base and smaller one at tip red, basal spot more or less blackened at tip. Corium with red oblique dash on costa midway to costal plaque, another red stripe arising on costa at anterior end of plaque, almost surrounding it, connected to the claval suture between its two spots and ending in the base of cell M_4. Cross veins red, margined on outside with hyaline, which is in turn margined with fuscous. Black spot in posterior margin of costal plaque and apex of cell R_3. Ventral surface stramineous more or less suffused with pink.

Genitalia. Pygofer hook U-shaped with outer fork about same thickness as inner but about a third shorter. Foot of style of medium size; heel prominent; base almost straight; posterior point about one half as long again as base of foot; anterior point short and sharp, about half as long as toe is wide. Aedeagus in dorsoventral view bell-shaped, processes bifid almost entire length, reaching to tip of shaft.

Type. Female, Plummer's Island, Md., March 28, 1915. For some reason McAtee did not name an allotype, therefore the male

paratype, Plummer's Island, Md., Dec. 21, 1915, described above, is so designated.

This is a very abundant species in the United States on grape east of the Rocky Mountains.

Erythroneura compta var. *rufomaculata* McAtee

Erythroneura comes var. *rufomacultata* McAtee, W. L., Bul. Ill. Nat. Hist. Sur., April, 1924, p. 43.

Dissections of the male genitalia of this form reveal no differences from *E. compta.* Summer specimens of the right age usually have the red marking as indicated in the original description.

42. *Erythroneura comes* (Say)

Tettigonia comes Say, Thomas, Ins. Jour. Ac. Nat. Sci. Phila., LV, p. 343; 1825.

General ground color yellowish-white, marked with orange. Vertex with inverted U-shaped mark with lateral extensions enclosing white spots next each eye. U mark continued on pronotum as Y-shaped vitta reaching posterior margin, an additional vitta on each lateral margin. Scutellum with basal angles yellow often bordered with orange, tip orange. Clavus with usual basal anchor-shaped spot and a much smaller one at tip. Corium with angular dash on costal margin near base, another vitta arising on costa at anterior end of costal plaque enlarging to meet claval suture near its middle, almost surrounding plaque, then angling to end in base of cell M_4. Cross veins usually pink, apical cells more or less infuscated. Black spots in posterior end of costal plaque, base of cell M_4 and in apex of R_3.

Genitalia. Pygofer hook of the U type, outer process about two thirds as long as inner. Style with large foot; heel marked; base straight; anterior point short, fairly sharp; posterior point longer than foot, sides almost parallel, usually slightly sinuate. Aedeagus in dorsoventral view oval, very broad, apex almost straight; processes longer than shaft, diverging on outer third with a distinct notch or tooth on their margin near middle.

This notch is the distinctive character of this species.

Since the types of this species are lost the male specimen described above, Leavenworth county, Kansas, April 11, 1930, is designated neotype.

This is a very common species on grape throughout the United States east of the Rocky Mountains.

43. *Erythroneura tacita* n. sp.

Resembling *Erythroneura nudata* McA. in the narrow markings, but larger; posterior point of style almost absent; pygofer hook single and aedeagus very long and narrow with bifid tip.

General ground color whitish, marked with orange. Vertex with median longitudinal band often enclosing two long white areas, continued across pronotum enclosing a white arc on anterior margin. Pronotum with lateral orange bar not reaching posterior margin. Clavus with usual anchor-shaped mark and small mesal spot just before tip. Corium with orange dash at base, another surrounding costal plaque connected to claval suture slightly beyond middle and ending on Cu before cross veins. Cross veins red. Black spot in posterior end of costal plaque and another at base of cell M_4. Venter stramineous, mesosternum dark.

Genitalia. Pygofer hook single, U-shaped, heavy at base. Foot of medium size; almost no heel or posterior point; anterior point long, less than right angle. Aedeagus in ventral view with flattened bifid tip, pair of heavy diverging processes at base, and between basal processes and shaft proper a curved, flattened, enlarged area.

Holotype, male, allotype, female, 15 male and 10 female paratypes, Republic, Wash., August 6, 1931, R. H. Beamer; 6 female paratypes, Oliver, B. C., August 6, 1931, R. H. Beamer; 1 male, Meritt, B. C., and 1 male, Dixie, Ore.; 17 females and 11 males, Poudre river, Colo., Aug. 22, 1931, R. H. Beamer.

The specimens were swept from *Cornus* sp.

44. *Erythroneura gilensis* Beamer

Erythroneura gilensis Beamer, R. H., Annals Ent. Soc. Am., vol. 22, p. 123, 1929.

This species is very close to *E. beameri* Rob., but may be separated from it by its larger size, by narrower, more broken markings and by the processes of aedeagus not diverging at so great an angle.

A fairly common species on grape in Arizona.

Erythroneura octonotata Walsh

Erythroneura octonotata Walsh, B. D., Prair. Farm., Sept. 6, 1862, p. 149.

The original description follows: "Whitish. Head as in the preceding. *(ziczac.)* Thorax a little clouded with fuscous. Abdominal and ventral joints, in mature specimens dusky except at tip. Tips of tarsi dusky. Elytra whitish subhyaline, with the same three spots as the preceding, and in addition, one on the inner

margin not far from the base; on the cross veins an irregular fuscous band, and on the disk a small brown cloud, often obsolete. Length, a little over one tenth inch."

I have not been able to place the species that Walsh must have had when he wrote the above description. It fits almost equally well either of the two species which are known in this paper as *Erythroneura compta* McAtee and *E. delicata* var. *accepta* McAtee, but in both of these there are always orange marks on the tegmen and in the first, black marks on the scutellum. When one considers the description of the color of *E. ziczac* which immediately precedes that of *E. octonotata*, I feel convinced that he would not have omitted these marks.

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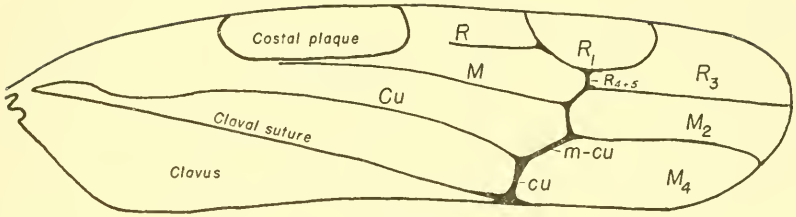
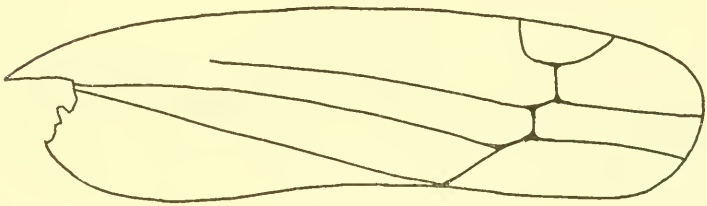
PLATE XVII

Wing venation of the four groups of Erythroneura.

PLATE XVII



VULNERATA GROUP



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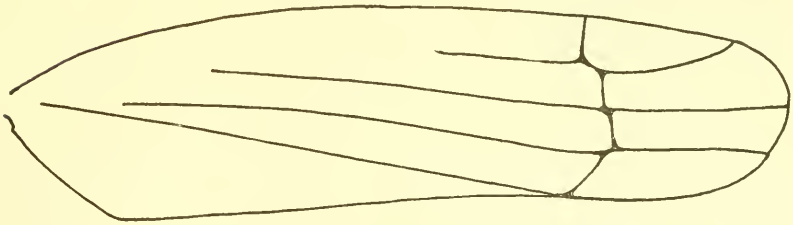
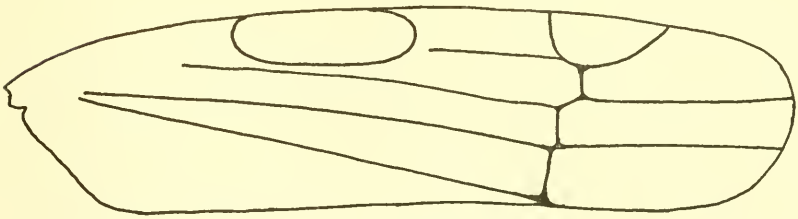


MACULATA GROUP

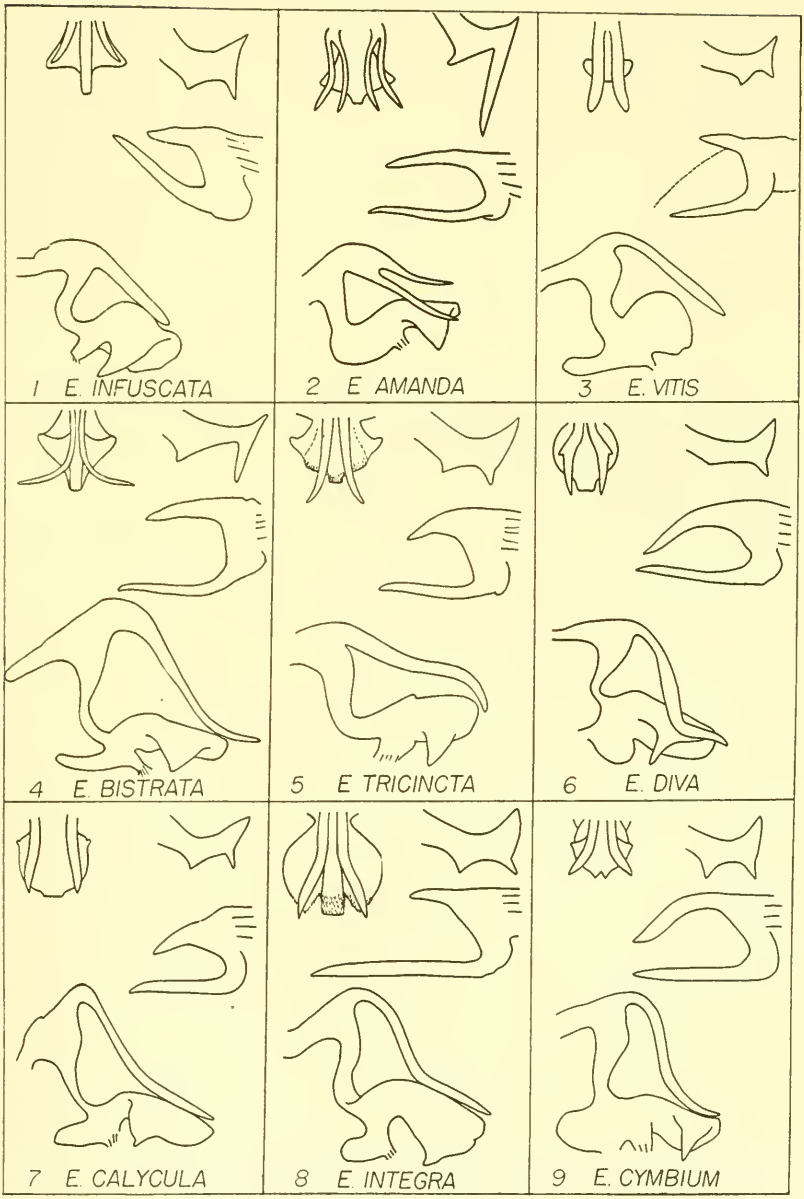


COMES GROUP

PLATE XVIII

1. *E. infuscata* (Gill.) Dorsoventral view of aedeagus, foot of style, pygofer hook and lateral view of aedeagus.
2. *E. amanda.*
3. *E. vitis* Harris.
4. *E. bistrata* McAtee.
5. *E. tricincta* Fitch.
6. *E. diva* McAtee.
7. *E. calycula* McAtee.
8. *E. integra* McAtee.
9. *E. cymbium* McAtee.

PLATE XVIII


1 E. INFUSCATA
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5 E. TRICINCTA
6 E. DIVA
7 E. CALYCULA
8 E. INTEGRA
9 E. CYMBIUM

PLATE XIX

10. *E. fraxa* Robinson. Dorsoventral view of aedeagus, foot of style and pygofer hook. Lateral view of aedeagus.
11. *E. acuticephala* Robinson.
12. *E. elegans* McAtee.
13. *E. cancellata* McAtee.
14. *E. aclys* McAtee.
15. *E. prosata* Johnson.
16. *E. ziczac* Walsh.
17. *E. elegantula* Osborn.
18. *E. coloradensis* (Gill.).

PLATE XIX

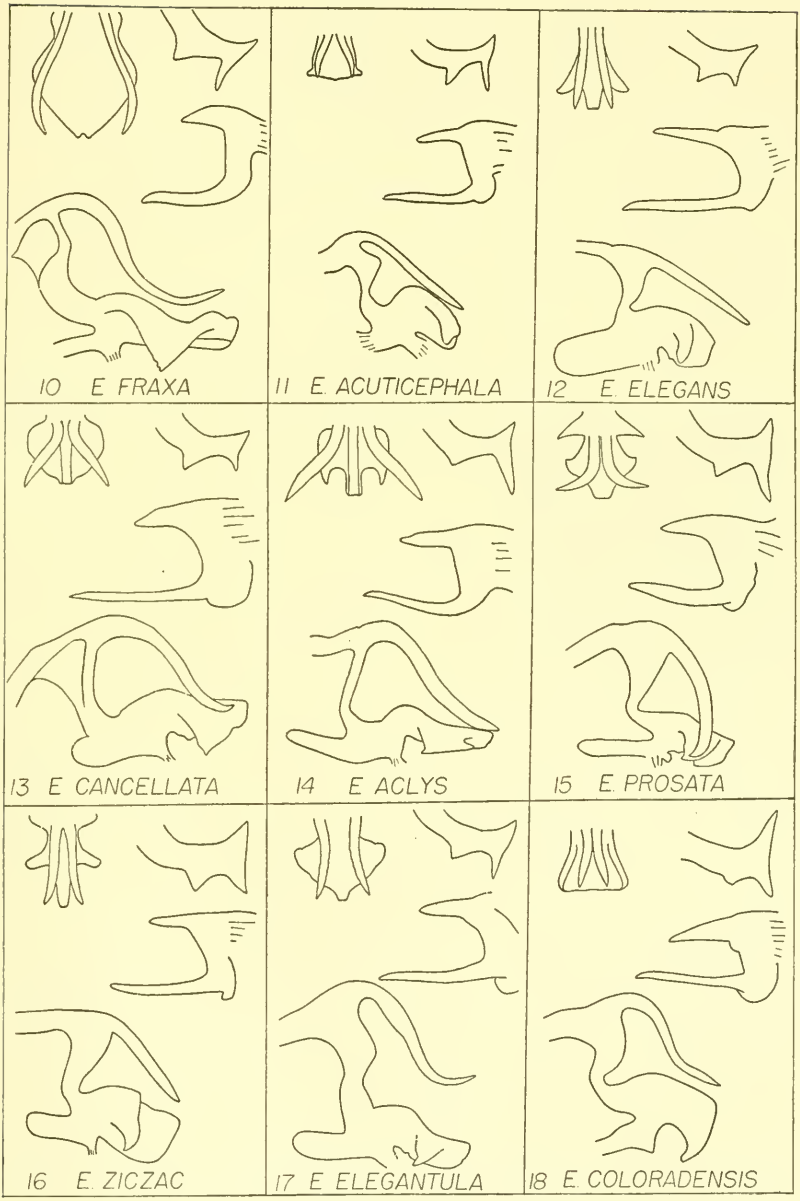

10 E FRAXA
11 E. ACUTICEPHALA
12 E. ELEGANS
13 E CANCELLATA
14 E ACLYS
15 E. PROSATA
16 E. ZICZAC
17 E ELEGANTULA
18 E. COLORADENSIS

PLATE XX

19. *E. palimpsesta* McAtee. Dorsolateral view of aedeagus, foot of style and pygofer hook. Lateral view of aedeagus.
20. *E. pontifex* McAtee.
21. *E. kanwakae* Robinson.
22. *E. anfracta* Beamer.
23. *E. vitifex* Fitch.
24. *E. caetra* McAtee.
25. *E. rosa* Robinson.
26. *E. reflecta* McAtee.
27. *E. prima* n. sp.

PLATE XX

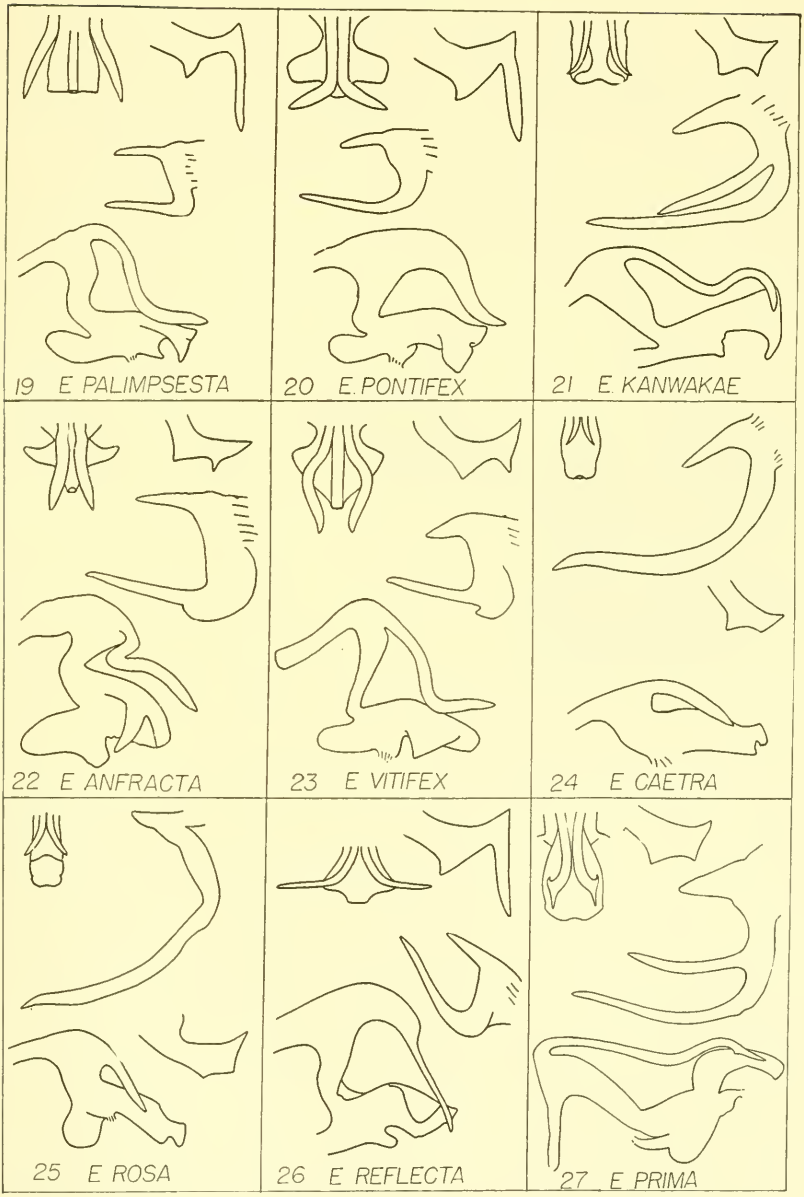

19 E. PALIMPSESTA
20 E. PONTIFEX
21 E. KANWAKAE
22 E ANFRACTA
23 E VITIFEX
24 E CAETRA
25 E ROSA
26 E REFLECTA
27 E PRIMA

PLATE XXI

28. *E. nudata* McAtee. Dorsolateral view of aedeagus, foot of style and pygofer hook. Lateral view of aedeagus.
29. *E. beameri* Robinson.
30. *E. vaga* Johnson.
31. E. *ancora* Beamer.
32. *E. omaska* Robinson.
33. *E. delicata* McAtee.
34. *E. corni* Robinson.
35. *E. bidens* McAtee.

PLATE XXI

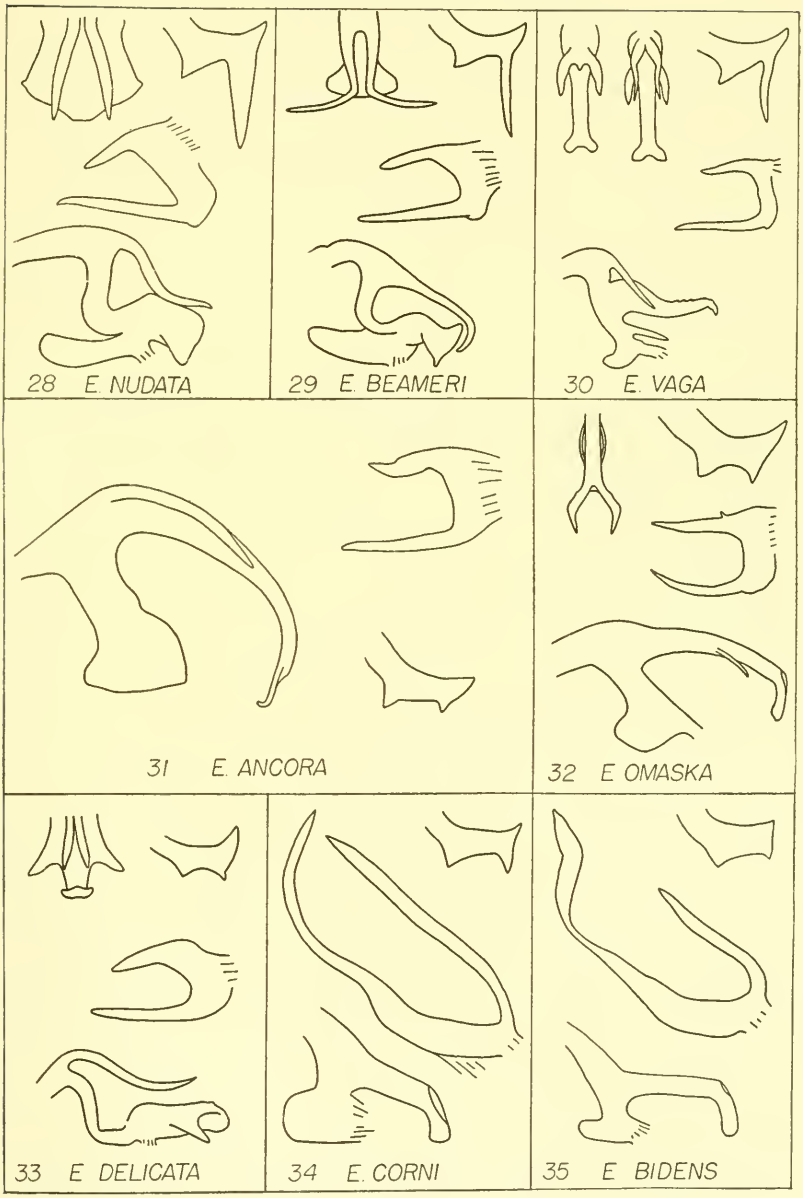
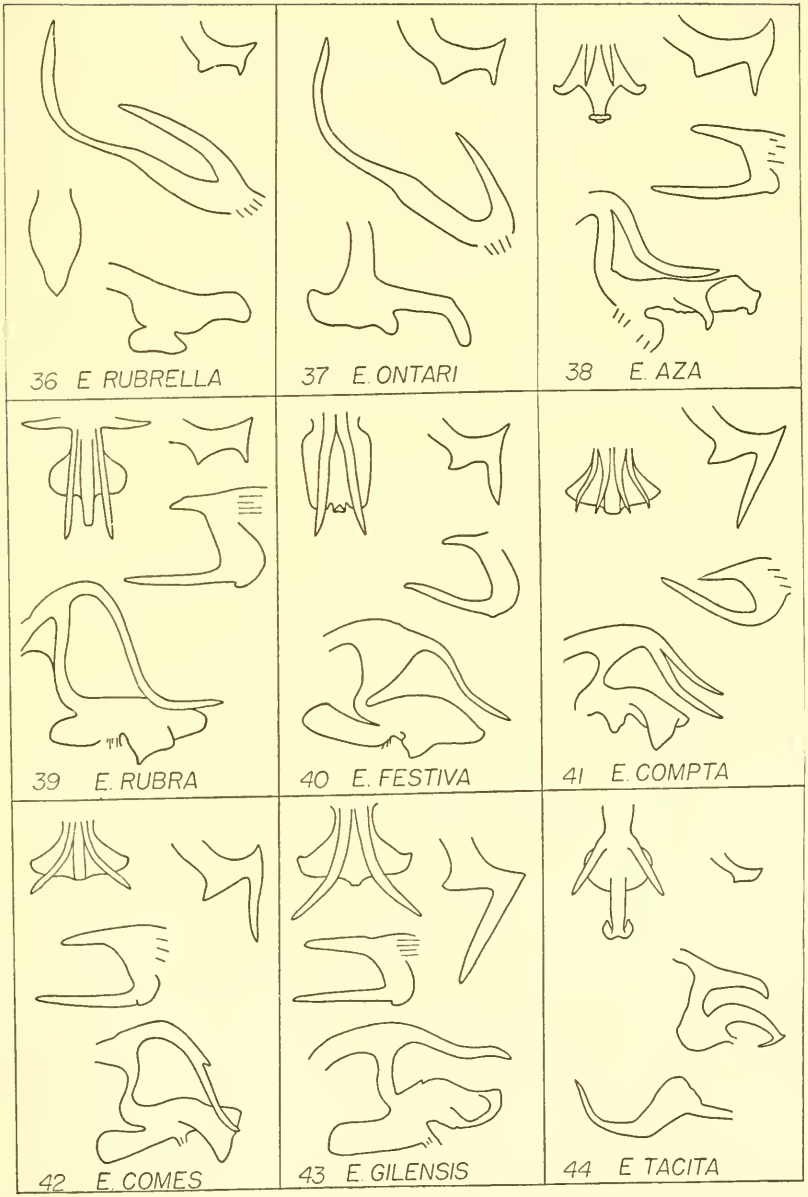

28 E. NUDATA
29 E. BEAMERI
30 E. VAGA
31 E. ANCORA
32 E OMASKA
33 E DELICATA
34 E. CORNI
35 E BIDENS

PLATE XXII

36. *E. rubrella* McAtee. Dorsolateral view of aedeagus, foot of style and pygofer hook. Lateral view of aedeagus.
37. *E. ontari* Robinson.
38. *E. aza* Robinson.
39. *E. rubra* (Gill.).
40. *E. festiva* n. sp.
41. *E. compta* McAtee.
42. *E. comes* (Say).
43. *E. gilensis* Beamer.
44. *E. tacita* n. sp.

PLATE XXII


36 E RUBRELLA
37 E. ONTARI
38 E. AZA
39 E. RUBRA
40 E. FESTIVA
41 E. COMPTA
42 E. COMES
43 E. GILENSIS
44 E TACITA

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Alconeura of the United States (Homoptera, Cicadellidae)

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ABSTRACT: The *Alconeura* group, separated from the *Dikraneura* by Ball and DeLong (1925), retains its generic rank with the addition of nine new species. The numerous specimens studied were collected chiefly from the

southern and western regions of the United States. Specific distinctions are primarily drawn from characters of the dissected male genitalia, and the technique for preparation of these structures is given in detail. A key to the nineteen species described from the United States is provided, and complete descriptions with locality notes are presented for them: *Alconeura planata* Ball and DeLong (p. 318), *A. necopinata,* n. sp. (p. 318), *A. beameri,* n. sp. (p. 319), *A. balli* Beamer (p. 319), *A. tricolor* (Van Duzee) (p. 320), *A. fulminea* Lawson (p. 321), *A. dorsalis* (DeLong) (p. 321), *A. unipuncta* (Gillette) (p. 322), *A. quadrimaculata* Lawson (p. 324), *A. derecta,* n. sp. (p. 325), *A. insulae,* n. sp. (p. 325), *A. dodonana* Beamer (p. 326), *A. lappa,* n. sp. (p. 327), *A. macra,* n. sp. (p. 327), *A. rotundata* Ball and DeLong (genotype) (p. 328), *A. nudata* Ball and DeLong (= *unipuncta* var. *nudata*) (p. 329), *A. languida,* n. sp. (p. 330), *A. luculenta,* n. sp. (p. 331), *A. cornigera,* n. sp. (p. 332). A note on *A. quadrivittata* (Gillette) from the Bahamas is added, and the literature of the genus is given. Illustrations are of the aedeagus and pygofer process of each species, and two typical forewing tips. Types of new species are in the Francis Huntington Snow Entomological Collections at the University of Kansas.

GENERIC DISTINCTIONS

THE Alconeura group was first generically distinguished from the Dikraneura in 1925 by Ball and DeLong, who considered an angulate or pedunculate second apical cell determinative, overlooking, as McAtee (1926) suggests, the extreme variability of this character. However, the insufficiency of the first distinction should not cause a too hasty rejection of the generic significance of the group, since there are plain indications that the present assembly of species can be recognized most conveniently as a separate genus.

It should be stated at once that the pedunculate apical cell is distinctly a characteristic of the Alconeura, and while it may appear exceptionally among the Dikraneura, it is never as admirably developed. In none of our species of Alconeura is the apical cell simply angulate.

The most obvious individualizing mark of the genus is the dark apical dot which appears in the third or fourth cell and frequently touches or lies upon the third vein. This may also be observed in the Dikraneura, but there it is not accompanied by the pedunculate apical cell.

There is evidence that the dissected male genitalia may be discriminative in the two genera, but this is problematical, since the forms of genitalia are highly specific and vary a great deal within a genus. Certainly the clear division of Alconeura and Dikraneura by external properties is dissuasion enough from the tedious undertaking of logically gathering in two major classes these less accessible structures.

Nineteen species of the Alconeura have been distinguished, having in common these characteristics: a marginal vein on the underwing, with two closed cells at the apex; four apical cells on the forewing, the second cell pedunculate; a dark apical dot in the third or fourth cell, often touching or lying upon the third vein; the vertexal angle but slightly obtuse or acute; a length of 2.5 mm. to 3.5 mm.; and, usually, bright coloration. *Alconeura rotundata* was described as the genotype by Ball and DeLong; this species displays very well the characters enumerated above and, indeed, its orange-yellow markings on a creamy-white background are typical of the major part of the genus.

The notable addition of nine new species to a genus in which but ten were properly recognized in 1934 may be ascribed to the good fortune of having available a wondrous amount of material collected by Dr. R. H. Beamer and others, and type specimens of all the described species. Sincere appreciation for their kindness and cooperation must be expressed to Dr. E. D. Ball, University of Arizona; Dr. D. M. DeLong, Ohio State University; Mr. P. W. Oman, United States National Museum; and particularly to Dr. R. H. Beamer, University of Kansas.

EQUIPMENT AND METHOD

This study of the Alconeura was undertaken with the definite purpose of establishing previously described species and distinguishing new species by means of the dissected male genitalia, the impetus for this taxonomic endeavor coming directly from antecedent studies of the Erythroneura. The technique for dissection and study of the genital structures is necessarily given here in some detail, and may be esteemed a culmination in method, for literally hundreds of specimens were dissected, with many complete sacrifices, in its perfection.

It is a sound principle for a worker to know well his tools, and this acquaintance is best made before the work is begun. The list following will be found helpful in arranging the equipment in an orderly outlay, which must be regarded as essential to the surest and quickest attack on any sort of problem in anatomizing.

The articles are presented approximately in order of employment:

A dissecting microscope.

A thick slice of art eraser, holed to admit the head of the insect pin.

A small dissecting needle with a sharp, flattened tip for removing the insect abdomen.

Dissection number labels for the pinned specimens, giving the generic name, number of the dissection, and the name of the dissector.

A tiny wire loop provided with a convenient handle for lifting the abdomen into and from the solutions.

Two small porcelain casseroles: one to hold caustic potash (10% solution) and the other distilled water.

An alcohol lamp and stand for heating the caustic potash.

Glycerine: the medium within which the dissection is made.

Microscope slides.

A small linen towel for wiping off the slides.

A soft wax pencil for noting temporarily upon the slide the dissection number.

A binocular microscope provided with dissecting stage and hand rests.

Two very fine needles (minuten nadeln): one straight, one bent into a right angle, provided with convenient handles.

Microscope object labels.

De Faure's mounting fluid. (Gum arabic, 30 grms.; chloral hydrate, 50 grms;. chlorhydrate of cocaine, 0.5 grm.; glycerine, 20 cc.; distilled water, 50 cc.) This beautifully clear mounting fluid must be very carefully mixed and filtered. Any other satisfactory mounting fluid may be substituted.

Cleaning fluid for slide cover glasses. (Hydrochloric acid, 1 cc.; alcohol, 95%, 100 cc.)

Slide cover glasses (circles, 15 mm.).

A microscope with reasonably high magnification for examining the finer details of the dissected structures.

Technique, in whatever manner described, must always be individual in application; however, it should be remembered that nothing is more destructive to quick attainment of worthy results than a haphazard method. While the experience of a very few dissections will best enable the worker to locate the equipment most advantageously, it must be borne in mind from the first that a logical sequence in the placement of tools and a plan of action will undoubtedly secure the happiest conclusion of the process in the shortest time. Accuracy and a certain finesse are most to be desired; yet it is undeniably heartening to feel that more time may be given to studying the dissections than to the routine of making them. The systematic approach suggested here will be found imperfect, but it has made possible an average of twenty dissections an hour and may prove helpful to those who wish to determine positively large series of the Alconeura or other Eupterygine leaf hoppers.

1. Removing the Abdomen

Fill a porcelain casserole with caustic potash and place it upon a stand over the lighted alcohol lamp, adjusting the wick so that the solution does not bubble vigorously. As the heated solution

evaporates during a series of dissections, replenish alternately with distilled water and caustic potash.

Fill a casserole with distilled water and place near the alcohol lamp.

Place the art eraser centrally on the dissecting microscope stage. A binocular microscope may be used, but the dissecting microscope is preferable since, after removal of the abdomen, the lens arm may be swung away, leaving a clear field for operations with the wire loop and for removing the specimen.

Invert the pinned insect upon the art eraser; a plain view is, of course, necessary and interfering labels on the pin must be turned slightly aside.

Remove the abdomen, observing through the lens, with the flat-tipped needle. This instrument is best held like a pen and the abdomen should be removed by gently thrusting the tiny chisel point between abdomen and thorax. Breaking-off is most easily accomplished at this point; although, exceptionally, the genital capsule alone may be removed most satisfactorily.

Withdraw the lens arm, and dipping the wire loop into the caustic potash, touch it to the abdomen, lifting it into the solution.

2. Labeling the Pinned Specimen

Each dissected specimen must be numbered so that the permanent microscope slide mount of the genital structures may be definitely referred to it. This is best done with small regular-sized three-line labels upon which are printed the generic name and the name of the dissector, the middle line being left blank for writing in the dissection number, and it is best to use India ink for this purpose.

3. Preparing for Dissection

Carefully clean a microscope slide and note the dissection number across one end, using the wax pencil.

Place a droplet of glycerine on the slide and center it upon the binocular microscope stage with an end toward the observer. This position allows working with the guiding fingertips close to the dissection without troublesomely nudging the slide.

Remove the abdomen from the caustic potash, in which it should have been heated from two to five minutes, using the wire loop, and submerge it in the distilled water. (At this point the abdomen

of another specimen may be removed and transferred to the caustic potash.)

Place the abdomen within the glycerine droplet, observing with the mieroseope. Use transmitted light.

4. DISSECTING

Take up the fine needles, the right-angle in the left and the straight-point in the right hand, grasping them, not as a pen is held, but with the handles resting lightly on the tips of the first two fingers and over the backs of the second pair.

Using the handrest for the wrists, establish the fingers upon the stage and bring the needles together within the glycerine.

Observing with the highest power lenses which permit a clarity of vision, turn the abdomen so that the genital capsule is normally oriented and directly centered in the field with the greater part of the abdomen extending toward the observer and with the pygofer processes visible on top. This is the proper position for dissection and should be reëstablished after an unsuccessful trial.

Insert the right-angle within the hollow of the capsule with the point toward the plates.

Plaee the straight-point alternately upon the two plates, gently pulling the needles apart. Under optimum conditions this single operation will remove the aedeagus and the styles, if carefully done, to a point where they may be easily detaehed from the pygofers and the rest of the genital apparatus. The plates are then pulled away quite simply and the dissection is complete. In more untoward circumstances it may be necessary to abandon the tugging at the plates and literally to pry out the aedeagus and styles with the straight-point while holding the capsule as before with the right-angle. The pygofers may be left intact on the capsule until permanently mounted.

The slide may now be set aside for study and the final mounting. (Here the next abdomen will be found ready for dissection; it should be dropped immediately into the distilled water and replaced in the caustic potash with another. This overlapping of processes so that a series may be quickly done can be easily mastered, but the first two or three dissections are best attempted singly.)

The dissection may be preserved indefinitely in glycerine and studied most conveniently within that medium since it permits a free turning about of the structures.

5. MOUNTING PERMANENTLY

Upon a gummed microscope object label note the dissection number in the upper left-hand corner and the locality data of the pinned insect at the bottom. These notations should be made in India ink, and a series referable to specimens to be dissected can best be made all at one time. The center of the label, it will be seen, is left blank for penciling in the name of the insect or the dissection number of a slide upon which the scientific name is given and which may typify the species. (For example, dissections in this study were assigned the key letters "GA" representing "Griffith Alconeura," and in most cases the permanent mounts bear, in addition to their proper corner labels, the cryptic middle signs "See GA 92, See GA 103;" etc., these references being to mounted dissections considered typical of their several species. And how much simpler it is to write *Alconeura languida* upon the one slide "GA 92," referring all subsequent dissections of the species to that number, than to note tediously the scientific name upon each mounted example.)

Place the glycerine mount upon the binocular microscope stage and center it with one end of the slide toward the observer.

Clean a slide and, attaching the label at one end, place it edge-to-edge with the glycerine mount. Drop a tiny bit of De Faure's mounting fluid in the center of the slide.

Holding the needles as before and observing carefully through the lenses, lift up the aedeagus and styles on the right-angle. Thrust immediately into the De Faure's fluid and without removing the needle, move the slide to the center of the stage, thus pushing the glycerine mount slightly aside.

Using a high power of the binocular lenses, arrange the genital structures with the aedeagus flat upon its side as in the included figures.

Withdraw the needles carefully and dip into the hot caustic potash to clean.

Using the tweezers, draw a cover glass from the cleaning fluid (which is best kept in a small, tightly covered dish) and dry upon the linen towel. Supporting the glass horizontally with the tweezers, touch a droplet of water to the underside, using the wire loop in the left hand. Gently lower the cover glass upon the slide until the drop of water merges with the mounting fluid, then release the glass immediately. (This bit of technique with cover glass and water

drop obviates the usual difficulty with air bubbles.) Tap the cover glass with the tweezers, watching through the binocular, to insure complete spreading of the mounting fluid to the edge of the cover glass.

Return the glycerine mount to its original central position, thrusting the permanent mount back.

Place a small drop of De Faure's fluid upon the permanent preparation next the aedeageal mount and farthest from the label. Introduce the pygofers from the glycerine into this second droplet as before.

Split the side of the genital capsule opposite that to which the pygofer processes are attached so that they may be pressed flat and still be in proper bilateral relation with each other. Apply the cover glass as before and press down tightly upon the flattened pygofers.

Allow the prepared slides to dry for a day and then ring the mounts with clear lacquer to prevent deleterious evaporation.

The dissected male genitalia structures are now permanently fixed in the best position for careful study and more powerful microscopes may be applied to them. With reasonable care in the use of the microscope, and the keys and figures given on following pages, positive determination of described species of Alconeura should be accomplished in a pleasingly swift fashion.

Since all species are established determinatively in this paper by means of the dissected male genitalia, presentation of an elaborate key employing other characters would be worth neither the time necessary for its composition, nor, certainly, the time which might be given to its use. Indeed, the inclusion of figures which show quite clearly the plain differences exhibited in the various forms of genital structure make any involved key superfluous.

However, a key to species, by whatever characters, is an effective way of pointing out descriminative points which might otherwise be overlooked, and the simple device which follows may be found workable, though the figures, which have been arranged in a systematic manner considered most helpful, should be consulted often.

The question of those troublesome female specimens collected without their attendant mates has not been unforeseen, but the descriptions of color patterns must be relied upon to place them as properly as can be until a larger series containing males may be collected. The task of correlating male and female genital characters is a very possible one, but it is much too extensive a piece of work to be finished and included in the present study.

KEY TO SPECIES

1.		Green, yellow, golden-brown, or orange-brown on white	2
		Bright orange to yellow on white	9
2.	(1)	Green, yellow or golden-brown, apical dot in base of fourth cell	3
		Orange-brown on white, apical dot in third cell	8
3.	(2)	Largely green, aedeagus with three slender processes arising in basal third	4
		Yellow or golden-brown, aedeagus without lanciform processes	7
4.	(3)	Green with red markings	5
		Green without red markings	6
5.	(4)	Vertex to scutellum red — *tricolor* (Van Duzee),	320
		Vertex to scutellum green, apex of forewing flecked with pink — *balli* Beamer,	319
6.	(4)	Distance from tip of median ventral process to margin of aedeageal shaft less than width of shaft — *planata* Ball and DeLong,	318
		Distance from tip of median ventral process to margin of aedeageal shaft greater than width of shaft — *necopinata*, n. sp.,	318
7.	(3)	Yellow, aedeagus diamond-shaped in ventral view — *beameri*, n. sp.,	319
		Golden-brown, aedeagus not diamond-shaped in ventral view — *fulminea* Lawson,	321
8.	(2)	Color on vertex, pronotum and scutellum fused; pygofer process with small spur on outer margin — *dorsalis* (DeLong),	321
		Color on vertex, pronotum and scutellum in spots; pygofer process without apical spur — *unipuncta* (Gillette),	322
9.	(1)	Apical dot in base of fourth cell, often touching cross vein	10
		Apical dot in third cell or upon third vein, removed from cross veins by more than its diameter	11
10.	(9)	Clavus with large stripe; wing-like short processes at tip of aedeageal shaft; pygofer process undivided at tip — *rotundata* Ball and DeLong,	328
		Clavus with three spots; without wing-like processes at tip of aedeageal shaft; pygofer process divided at tip — *dodonana* Beamer,	326
11.	(9)	Aedeageal shaft without important processes; pygofer process almost as long as aedeagus	12
		Aedeageal shaft with important processes; pygofer process much shorter than aedeagus	14
12.	(11)	Pygofer process double — *insulae*, n. sp.,	325
		Pygofer process single	13
13.	(12)	Pygofer process scimitar-shaped — *quadrimaculata* Lawson,	324
		Pygofer process almost straight — *derecta*, n. sp.,	325
14.	(11)	Pygofer process well-developed	15
		Pygofer process almost atrophied	17
15.	(14)	Aedeagus with pair of lateral processes at least half as long as shaft — *cornigera*, n. sp.,	332
		Aedeagus with lateral processes less than half as long as shaft	16
16.	(15)	Basal processes of aedeagus more than five — *lappa*, n. sp.,	327
		Basal processes of aedeagus less than five — *macra*, n. sp.,	327
17.	(14)	Tips of lateral processes on aedeagus bending dorsad — *languida*, n. sp.,	330
		Tips of lateral processes on aedeagus bending ventrad	18
18.	(17)	Tip of aedeageal shaft bending ventrad — *nudata* Ball and DeLong,	329
		Tip of aedeageal shaft straight — *luculenta*, n. sp.,	331

DESCRIPTIONS

The problem of systematically presenting the species of the Alconeura according to their external resemblances and the more important affinities of the dissected male genitalia is, by no means, an easy one. However, the most cursory examination allows a division of the genus in two groups: Those first separated in the preceding key. Although the orange-yellow and white phases make up the greater part of the genus, the best introduction may be given with

the other series which shows most clearly relationship with the Dikraneura.

In descriptions of male genitalia the basal width of the aedeagus is measured from the dorsal margin immediately distad of the membranous tuft to the ventral margin just distad of the articulatory piece. This line of measurement is illustrated in the figure of *Alconeura balli* Beamer.

Quotations given are from the original descriptions, and types recorded, unless otherwise stated, are in the Francis Huntington Snow Entomological Collections at the University of Kansas.

1. *Alconeura planata* Ball and DeLong

Alconeura planata Ball, E. D., and DeLong, D. M., Ann. Ent. Soc. Am., XVIII, 337, 1925.

Resembling *Dikraneura kunzei* Gillette, but with pedunculate second apical cell and black dot in base of fourth apical cell.

Color. Largely green. Vertex greenish-yellow with mesal white line often extending from apex to scutellum; pronotum mostly green, with greenish-yellow anterior margin; scutellum greenish-yellow with white markings. Forewing light green with blue-green mottlings particularly evident along claval suture. Apical veins lighter. Venter fuscous; face greenish-yellow near vertexal apex.

Genitalia. Aedeagus in lateral view over twice as long as width at base; shaft curving dorsad, bent in basal fourth into right angle with base, narrowing gradually, tip about one fourth width of base, abruptly curving dorsad; three lanciform processes, two lateral and one ventromedian, arising in basal third and paralleling shaft to apical third, laterals slightly longer. Pygofer process almost as long as aedeagus, base heavy, bent near middle into right angle, tapering evenly to attenuated tip.

"Described from eight examples taken by the senior author at Helper and Soldiers Summit, Utah, August 13, 1906. A remarkably distinct little species from the Wasatch Mountains."

Types studied: Allotype, male, and paratype, female (E. D. Ball Collection).

2. *Alconeura necopinata,* n. sp.

Resembling *Alconeura planata* Ball and DeLong, but with white line on vertexal margin very distinct and ventromedian lanciform process on aedeagus, forming almost 45° angle with shaft rather than nearly paralleling it; pygofer process heavier and less radically bent.

Color. Largely green. Vertex greenish-yellow, with white line on anterior margin joining eyes, and with mesal white line often ex-

tending to scutellum; pronotum mostly green, frequently with greenish-yellow margins; scutellum variably tinged with yellow and green. Forewing yellowish-green, usually mottled sparsely in faint blue-green; apical dot in base of fourth apical cell. Tip of forewing lighter. Venter fuscous; face often lighter near vertexal apex.

Genitalia. Aedeagus in lateral view about twice as long as width at base; shaft bending dorsad, apical portion at right angles with base, narrowing gradually, tip about one third width of base; three lanciform processes, two lateral and one ventromedian, arising in basal third and extending almost to tip of shaft, two laterals paralleling, median forming almost 45° angle with shaft. Pygofer process about as long as aedeagus, base heavy, slightly curving and evenly tapering to point.

Holotype, male; allotype, female; paratypes, twelve pairs: Mint Canyon, California, July 6, 1933, and July 31, 1935. Palmdale, California, July 6, 1933. R. H. Beamer.

3. *Alconeura beameri,* n. sp.

Resembling *Alconeura necopinata,* n. sp., but yellow rather than green and aedeagus without lanciform processes.

Color. Mostly yellow. Vertex with white line on anterior margin joining eyes, mesal white line often extending to scutellum; pronotum frequently white or lighter yellow anteriorly and at sides; scutellum yellow or greenish, usually figured with white. Forewing yellow with white or lighter spots particularly evident along claval suture; apical dot in base of fourth apical cell, infrequently very faint or apparently absent. Venter yellow; face usually with greenish tinge.

Genitalia. Aedeagus in ventral view diamond-shaped, lateral expanded portions with minute conical teeth on ventral surface; in lateral view bending dorsad, apical portion of shaft approaching right angle with base, narrowing slightly, curving dorsad to blunt tip. Pygofer process slightly more than half length of aedeagus, sickle-shaped; apical two thirds slender, sharp-tipped, bending at right angles to heavy base.

Holotype, male; allotype, female; paratypes, twelve pairs: Jacumba, California, August 12, 1935. Congress Junction, Arizona, August 13, 1935. R. H. Beamer.

4. *Alconeura balli* Beamer

Alconeura balli Beamer, R. H., Can. Ent., LXVI, 17, 1934.

"Resembles superficially *Alconeura planata* Ball and DeLong, but may easily be separated by the pink tips of the tegmen.

"General ground color yellowish-green mottled with lighter. Head conical, quite pointed with two slightly darker yellow marks or blotches near base. Pronotum with anterior border whitish-yellow, lacking the mottling, remainder of pronotum mottled. Scutellum of about same color as anterior border of pronotum. Tegmen pale greenish-yellow mottled with white to cross veins. Usually pink to tip slightly suffused with fuscous. Black spot in base of cell M_4. Venter dark throughout. Longitudinal veins white spotted, cross veins and apicals entirely white."

Genitalia. Aedeagus in lateral view over twice as long as width at base; apical portion at right angle with base and half as wide; three lanciform processes, two lateral and one ventromedian, arising in basal third and extending into apical third, paralleling line of shaft. Pygofer process about two thirds length of aedeagus, widest portion at base nearly one fourth length, bending abruptly in basal half and evenly tapering to point.

Types studied: "Holotype, male and allotype, female, Santa Rita Mts., Arizona, July 17, 1932, R. H. Beamer. Numerous paratypes, same data." Ashfork, Arizona, August 8, 1932; Prescott, Arizona, August 7, 1932, and July 7, 1933; Granite Dell, Arizona, July 30, 1933; R. H. Beamer.

5. *Alconeura tricolor* (Van Duzee)

Dicraneura tricolor Van Duzee, E. P., Trans. San Diego Soc. Nat. Hist., II, 56, 1914.
Alconeura tricolor (Van Duzee), Ball, E. D., and DeLong, D. M., Ann. Ent. Soc. Am., XVIII, 336-337, 1925.

Resembling *Alconeura planata* Ball and DeLong, but with vertex, pronotum and scutellum red.

Color. Mostly red and green. Vertex, pronotum and scutellum bright red. Vertex with milky-white line on anterior margin and usually from apex mesally to scutellum; pronotal lateral margins touched with milky-white. Forewing green, often mottled with white along claval suture. Apical dot in base of fourth cell. Venter fuscous and red, appendages red; face with inverted V in milky-white formed by stripes extending mesad from antennal bases.

Genitalia. Aedeagus in lateral view about twice as long as width at base; shaft bending dorsad, apical portion at 45° angle with base, narrowing in distal half to about one half width of base; three lanciform processes, two lateral and one ventromedian, arising in basal third and extending past tip of shaft, two laterals curving ventrad but closely paralleling, median forming almost 45° angle with shaft.

Pygofer process nearly as long as aedeagus, slender, bent near middle, very slightly tapered from base to point.

"Described from thirteen examples representing both sexes, taken at Lakeside and Foster in May" (California).

Types studied: A pair of homotypes (by R. H. Beamer), San Jacinto Mountains, California, June 30, 1933. Dulzura, California, August 9, 1935; Campo, California, August 10, 1935; Jacumba, California, August 12, 1935. R. H. Beamer.

6. *Alconeura fulminea* Lawson

Alconeura fulminea Lawson, P. B., Bull. Brooklyn Ent. Soc., XXV, 44, 1930.

Resembling *Alconeura necopinata*, n. sp., but with white line on vertexal margin continued across eyes, along lateral margins of pronotum and clavai suture; aedeagus without lanciform processes.

"Vertex, pronotum and scutellum rich golden brown. Vertex with narrow brown submarginal line and broad white marginal band which extends backward across eyes, sides of pronotum, and along length of clavai suture. Elytra olive green with distinct black spot in fourth apical cell opposite third cross vein. Underside for the most part greenish yellow. Abdomen sometimes largely fuscous."

Genitalia. Aedeagus in lateral view over twice as long as width at base, curving dorsad, with lines of dorsal and ventral margins nearly parallel to apical third, which bends sharply dorsad, tapering abruptly to point; dorsal and ventral margins in ventral view slightly expanded. Pygofer process approximately one third longer than shaft of aedeagus, from middle evenly tapering to point.

Types studied: Holotype, male; allotype, female; paratypes, two males and one female: Cameron county, Texas, August 3, 1928. Nogales, Arizona, June 25, 1933. R. H. Beamer.

7. *Alconeura dorsalis* (DeLong)

Dikraneura unipuncta dorsalis DeLong, D. M., Journ. N. Y. Ent. Soc., XXXII, 67-68, 1924.

Alconeura unipuncta dorsalis (DeLong), Ball, E. D., and DeLong, D. M., Ann. Ent. Soc. Am., XVIII, 336, 1925.

Dikraneura (*Alconeura*) *dorsalis* DeLong, McAtee, W. L., Journ. N. Y. Ent. Soc., XXXIV, 164, 1926.

Alconeura unipuncta dorsalis (DeLong), Lawson, P. B., Bull. Brooklyn Ent. Soc., XXV, 46, 1930.

Resembling *Alconeura fulminea* Lawson by white line margining dorsal longitudinal brownish band, but with apical dot in third, not fourth apical cell; pygofer process not as straight, curved into sickle form with marginal spur in distal half.

Color. Creamy-white with orange-brown markings. "Disc of vertex and pronotum, scutellum and clavus of elytra covered with a broad longitudinal brownish band which is bordered by a white band extending along margins of vertex from apex, across margins of pronotum on to elytra at base and along claval suture half way to apex." Corium suffused semihyaline with orange-brown vitta curving in from near humeral angle to margin apical half of claval suture; with darker line from midcostal margin to cross veins. Apical veins light with fumose margins; apical dot central in third apical cell. Tip of forewing fumose. Venter stramineous; face yellow.

Genitalia. Aedeagus in lateral view about twice as long as width at base, narrowing in apical third to about one half basal width, curving dorsad and gradually narrowing to rounded tip; line of ventral margin nearly semicircular; dorsal margin with distinct basal tooth. Pygofer process almost as long as aedeagus, about one fifth as wide at base, constricted in middle, widening apically and curving into sickle form with tooth on outer margin.

"This is a very common variety found in the everglades in company with *unipuncta* and is extremely abundant upon *Trima floridana* in everglade hammocks which are composed partially or entirely of this plant."

Types studied: A pair of paratypes, Miami, Florida, April 13, 1921 (D. M. DeLong collection). Other records from Florida are: Key Largo, August 9, 1930, R. H. Beamer. Cocoanut Grove, August 9, 1930, L. D. Tuthill. Biscayne Bay, P. R. Uhler collection.

8. *Alconeura unipuncta* (Gillette)

Dicraneura unipuncta Gillette, C. P., Proc. U. S. Nat. Mus., XX, 718, 1898.

Alconeura unipuncta (Gillette), Ball, E. D., and DeLong, D. M., Ann. Ent. Soc. Am., XVIII, 335-336, 1925.

Dikraneura (*Alconeura*) *unipuncta* Gillette, McAtee, W. L., Journ. N. Y. Ent. Soc., XXXIV, 163, 1926.

Alconeura unipuncta (Gillette), Lawson, P. B., Bull. Brooklyn Ent. Soc., XXV, 45, 1930.

Resembling *Alconeura dorsalis* (DeLong), but without dorsal longitudinal brownish band; pygofer process without marginal spur in apical half.

Color. Creamy-white with orange-brown markings. Vertex usually with orange inverted V from apex to posterior margin; pronotum most frequently with four orange vittae, ends of lateral pairs joined or more broadly fused; scutellum variably marked with yellow to orange-brown. Forewing with two orange to orange-brown spots on clavus, one frequently almost filling basal portion, an-

other just past middle, normally forming one half large mid-dorsal spot apparent when wings are closed, tip of clavus fumose; corium with orange to orange-brown vitta almost paralleling claval suture from near humeral angle to tip of clavus; fumose orange stripe extending in from midcostal margin to cross veins. Apical veins light with fumose borders; apical dot large, in third apical cell. Tip of forewing fumose. Venter stramineous, smokily suffused.

Genitalia. Aedeagus in lateral view about twice as long as width at base, narrowing in apical third to about one half basal width, curving dorsad to rounded tip; line of ventral margin nearly semicircular; dorsal margin with stout basal tooth. Pygofer process almost as long as aedeagus, slender, constricted just proximad to apical third which curves abruptly to sharp point.

"Described from three females and one male from the United States National Museum, one of which is labeled 'Coquillet, Collector, Calif., through C. V. Riley,' and three are labeled 'Coquillet, Los Angeles, Calif.'"

Types studied: Holotype, male (Type 3414, U. S. N. M.), and a paratype, female, found to be *Alconeura quadrimaculata* Lawson, a much lighter species. This apparent confusion of the two species evidently accounts for the emphasis on orange coloration in Gillette's description of *Alconeura unipuncta*, which is typically marked in even darker brown than *Alconeura dorsalis* (DeLong).

This species is very common and widely distributed, though typically Californian. Records from that state are: San Diego county, July 4, 1929; Alpine, July 9, 1929; Mint Canyon, July 6, 1929; San Jacinto Mountains, July 21, 1929; Marin county, August 3, 1929; Winters, August 6, 1929; Strawberry, August 8, 1929; Boulder Creek, July 18, 1933; Salinas, July 18, 1933; Gaviota, July 19, 1933; San Ardo, July 18, 1933; Nicolaus, June 27, 1935; Siskiyou, N. F., July 14, 1935; Nipomo, July 24, 1935; Claremont, July 29, 1935; Anza, August 6, 1935; R. H. Beamer. Giant Forest, July 28, 1929, L. D. Anderson. Van Duzee (1914) reports the species from Foster, Mussey's, and Alpine (San Diego county).

Ball and DeLong (1925) note that "specimens have been examined from Grant's Pass, Oregon; San Francisco, Sacramento, and Pasadena, California (Ball); Ash Creek, Arizona; Utica, Mississippi; Alabama and Biscayne Bay, Florida, (U. S. N. M.); Miami, Florida, (DeLong)."

McAtee (1926) records the species from Washington, D. C., July 2, 1913, W. L. McAtee; and Soledad, Cuba, March 14, 1925, J. G. Myers.

A specimen was taken in Glendale, Nevada, January 3, 1930, by David E. Fox on *Pluchea sericea,* and a number of other specimens in the U. S. N. M. bear the label "Ariz., Collection C. F. Baker."

Among the eleven species of *Alconeura* which are distinctively yellow and white, general resemblances are at once apparent, and in many instances coloration markedly intergrades. It is submitted, however, that closely related species not uncommonly exhibit such external similarity, and certainly in these cases there is no comparable intergradation of the male genital characters, although there are indubitable resemblances. Fully colored specimens of any two given species, however close, show plainly differences in the markings, one being invariably more definitely and extensively striped or spotted. Unfortunately, the optimum in coloration cannot always be obtained, and, as for many species in widely separate genera, the male genitalia must be regarded here as the positive means of classification.

9. *Alconeura quadrimaculata* Lawson

Alconeura quadrimaculata Lawson, P. B., Bull. Brooklyn Ent. Soc., XXV, 45, 1930.

Resembling *Alconeura unipuncta* (Gillette), but with much lighter coloration, marked with orange, not orange-brown; aedeagus without stout basal tooth on dorsal margin; pygofer process recurved into heavy, sharp-pointed hook.

"Vertex, pronotum and scutellum milky white, with traces of four yellow or orange-red lines on pronotum and hints of color in basal angles of scutellum. Elytra with two bright, well-separated, orange-red spots on each clavus, a yellow line between first and second sectors and sometimes a suggestion of yellow laterad of this near the costal margin; some of apical veins margined with fuscous, particularly along costal margin; a small but distinct black spot near middle of third apical vein. Underside pale except for black tarsal claws and tip of ovipositor."

Genitalia. Aedeagus in lateral view nearly twice as long as width of base; narrowing in apical third to less than one third basal width, curving dorsad to rounded tip; line of ventral margin nearly semicircular. Pygofer process nearly as long as aedeagus, base as wide as apical portion of shaft; constricted in middle, apex recurving, forming sharp-pointed hook.

Types studied: Holotype, female; allotype, male; paratypes, ten females and eight males: Pima county, Arizona, July 27, 1927. Also, one paratype, male, from Gila county, Arizona, August 6, 1927. R. H. Beamer. San Diego county, California, July 7, 1929; Alpine,

California, July 9, 1929; Sabino Canyon, Arizona, July 14, 1932; Baboquivari Mountains, Arizona, July 19, 1932; Patagonia, Arizona, August 22, 1935; R. H. Beamer. Verde Valley, Arizona, September 20, 1922; H. R. Brisley. Santa Rita Mountains, Arizona, June 16, 1933; Patagonia, Arizona, June 24, 1933; P. W. Oman. Los Angeles county, California, Coquillet. Three specimens taken in Pasadena, California, April 4, 1928, bear the label "sycamore, Arroyo Seco."

10. *Alconeura derecta*, n. sp.

Resembling *Alconeura quadrimaculata* Lawson, but smaller, with pygofer process straight, not hook-shaped.

Color. Creamy-white with orange markings. Vertex with orange inverted V extending from apex to posterior margin, widening and touching eyes; pronotum with irregular orange vittae forming an M; scutellum orange and creamy-white. Forewing with two large yellow spots on clavus, one basal and ovate, other slightly beyond middle, usually forming one half of dorsal spot evident when wings are at rest; corium with bright yellow vitta curving in from costal margin and paralleling distal two thirds of claval suture almost to cross veins, joined by shorter smoky-yellow stripe from mid-costal margin. Apical veins yellowish, margined with fumose; apical dot in third apical cell. Tip of forewing darkened. Venter stramineous.

Genitalia. Aedeagus in lateral view about twice as long as width at base, narrowing abruptly in apical third to approximately one third basal width and curving dorsad to truncate tip; line of ventral margin roughly semicircular. Pygofer process as long as aedeagus, slender and nearly straight, so twisted as to appear constricted just before obliquely truncated apex.

Holotype, male; allotype, female; paratype, female: Key Largo, Florida, August 9, 1930. Batesburg, South Carolina, August 24, 1930. R. H. Beamer.

11. *Alconeura insulae*, n. sp.

Resembling *Alconeura derecta* n. sp., but more delicately marked with yellow; oblique lines near margin of vertex forming inverted V extending to eyes; two processes on pygofer.

Color. Creamy-white with golden-yellow markings. Vertex with yellow inverted V near anterior margin, extending to eyes, often indistinct apically, continuing medianly to posterior margin in two parallel lighter lines; pronotum with yellow lines forming irregular trapezoid in each half, adjacent median sides of these lateral figures almost parallel; angles of scutellum yellow. Forewing with yellow

spots on clavus, one basal and ovate, another just beyond middle and forming one half of dorsal spot completed when wings are closed; corium with yellow stripe from near humeral angle to middle of claval suture, and with similar stripe extending obliquely inward from midcostal margin, enlarging at tip of clavus, joining small fumose mark. Apical veins pale yellow, fumosely bordered near costal margin; apical dot in midapical cell, touching or upon third vein. Tip of forewing suffused with yellow. Venter stramineous.

Genitalia. Aedeagus laterally compressed, in lateral view major portion about twice as long as wide; thicker dorsoventrally near laterally expanded apex, and with slender process briefly paralleling ventral margin in basal third of aedeageal shaft. Pygofer with two processes, semiequal in length, obliquely joined at base forming U-shaped projection occupying space approaching two thirds size of aedeagus; inner spur slightly sinuate, gradually tapering to point; outer spur tapering abruptly in apical third and incurved.

Holotype, male; allotype, female; paratypes, twelve pairs: Key Largo, Florida, August 9, 1930, R. H. Beamer.

12. *Alconeura dodonana* Beamer

Alconeura dodonana Beamer, R. H., Can. Ent., LXVI, 17, 1934.

"Resembling *Alconeura quadrimaculata* Lawson, somewhat, but with many more orange markings, and a flattened face instead of arched.

"General ground color yellowish white. Vertex with inverted V-shaped orange mark with arm of V broadened to touch eyes. Pronotum with inverted undulating W-shaped orange mark reaching both anterior and posterior margins. Scutellum all orange except small square anteriomesal yellowish white spot. Clavi with large, almost circular, basal orange spot and an elongated bilobed mesal one. Coria with diagonal orange dash at anterior end of costal plaque ending in enlarged rounded area at claval suture; another slightly narrower and shorter diagonal dash at posterior end of costal plaque and an oval spot near its inner end. Cross veins light, margined with fuscous. Small round black spot in base of cell M_4. Venter stramineous suffused with orange. Tip of ovipositor often black."

Genitalia. Aedeagus in lateral view more than three times as long as width of base; shaft curving dorsad, evenly tapering to slender dorsad-bent tip; line of ventral margin semicircular; pair of lanciform processes arising at base and paralleling aedeagus, though not quite as sharply curved. Pygofer process about two thirds as

long as aedeagus, base heavy, slightly narrower in distal portion, apex bifurcate.

Types studied: "Holotype, male and allotype, female, Sabino Canyon, Arizona, July 14, 1932, R. H. Beamer: 19 female and one male paratypes same data. One female paratype, Baboquivari Mts., Ariz., July 19, 1932, R. H. Beamer."

"All specimens were collected on *Dodonaea viscosa* var. *angustifolia*."

13. *Alconeura lappa*, n. sp.

Resembling *Alconeura quadrimaculata* Lawson, but smaller and with pronotal markings more definitely vittate, not fused; aedeagus with several basal spur-like processes; pygofer process reduced to stout tooth.

Color. Creamy-white with orange-yellow markings. Vertex with orange inverted V, apically obscure, extending to posterior margin, frequently touching eyes; pronotum with four orange vittae, each lateral pair often fused posteriorly and more faintly joined anteriorly; angles of scutellum orange. Forewing with two yellow spots on clavus, larger one near base and ovate, other in middle, becoming half of dorsal spot formed when wings are at rest; corium with yellow stripe bordering distal two thirds of claval suture, joined obliquely at base with similar stripe coloring proximal half of costal margin. Apical veins yellow, fumosely outlined; apical dot in third apical cell, touching or upon third vein. Tip of forewing yellow, delicately suffused. Venter stramineous to brighter yellow.

Genitalia. Aedeagus with many spur-like processes on basal half; in lateral view, shaft apically slender (about one third width of base), divided into ventral and dorsal arms; basal width of aedeagus less than one fourth length. Pygofer process about one half length of aedeagus, semitriangular with broad base and sharp tip.

Holotype, male; allotype, female; paratypes, fifteen males and twelve females: Huachuca Mountains, Arizona, July 8, 1932, R. H. Beamer. Additional paratypes: two males and one female, Sabino Canyon, Arizona, October 8, 1932 (E. D. Ball collection); one male, Santa Rita Mountains, Arizona, June 27, 1933, P. W. Oman (U. S. N. M.). Chiricahua Mountains, Arizona, July 8, 1932; Sabino Canyon, Arizona, July 12 and July 14, 1933; R. H. Beamer.

14. *Alconeura macra*, n. sp.

Resembling *Alconeura lappa*, n. sp., but tips of forewings more deeply suffused with fumose-yellow, apical dot distinctly larger;

aedeagus with less than five basal spurlike processes; pygofer process with attenuated tip.

Color. Creamy-white with orange-yellow markings. Vertex with orange-yellow inverted V, apically indistinct, lateral stripes extending with little widening to posterior margin, often touching eyes; pronotum marked with four orange-yellow vittae, lateral pairs lightly joined at anterior end, often apparently connected posteriorly; scutellum orange-yellow excepting small anteromedian white square. Forewing with two orange-yellow claval spots, one basal, elongate-oval, one in middle part completing oval dorsal spot when wings are closed; corium with orange-yellow stripe curving inward from costal margin and paralleling distal two thirds of claval suture to cross veins, meeting fumose mark interruptedly proceeding in from yellowish spot on midcostal margin. Apical veins yellow with dark borderings; apical dot on third vein. Tip of forewing yellow, smokily suffused. Venter straminceous, occasionally brighter yellow.

Genitalia. Aedeagus with less than five spurlike processes on basal half; in lateral view, shaft apically slender (about one third width of base), divided into ventral and dorsal arms; basal width of aedeagus nearly one fifth of length. Pygofer process about one half length of aedeagus, semitriangular, broad at base with sharp, attenuated tip.

Holotype, male; allotype, female; paratypes, ten pairs: Pensacola, Florida, July 12, 1934, R. H. Beamer. Additional paratypes: six males and four females, Alabama, collection C. F. Baker; two males, Utica, Mississippi, August; two males and one female, Tallulah, Louisiana (on cotton), September 6, 1929, R. L. McGarr; two females, Mullins, South Carolina (on *Hypericium*), May 5, 1932, P. W. Oman (U. S. N. M.). Sanford, Florida, July 25, 1934; Hilliard, Florida, July 28, 1934; Vinton, Louisiana, December 25, 1931; R. H. Beamer. Sanford, Florida, June 6, 1933, C. O. Bare. Hamilton, Mississippi, July 15, 1930, L. D. Tuthill. Douglas county, Kansas, August 17, 1928, and July 25, 1929, P. B. Lawson.

15. *Alconeura rotundata* Ball and DeLong

Alconeura rotundata Ball, E. D., and DeLong, D. M., Ann. Ent. Soc. Am., XVIII, 335, 1925,

Alconeura rotundata Ball and DeLong, Lawson, P. B., Bull. Brooklyn Ent. Soc., XXV, 46, 1930. (Evidently confused with *Alconeura nudata* Ball and Delong, and *Alconeura languida*, n. sp.)

Resembling *Alconeura unipuncta* (Gillette) but stouter, marked with yellow not darkened with fumose, apical dot in base of fourth, not in third cell; tip of aedeagus in ventral view with winglike processes.

Color. Creamy-white with orange-yellow markings. Vertex with two orange-yellow vittae, almost forming inverted V; orange spot next anterior margin of eye; pronotum with four irregular orange-yellow vittae; angles of scutellum marked with orange-yellow. Forewing white, semihyaline with two yellow vittae paralleling claval suture, one on clavus from basal portion into distal third, one on corium from near humeral angle almost to cross veins; large yellow mark on midcostal margin. Apical veins yellow with fulvous margins; apical dot in base of fourth cell. Tip of forewing fulvous. Venter stramineous.

Genitalia. Aedeagus in lateral view about three times as long as basal width, narrowed in apical third to nearly one third middle width, curving slightly dorsad; with pair of winglike processes at tip, widely divided to point of attachment into two sharp-pointed spurs on either side of apex of shaft. Pygofer process little wider than apical portion of aedeagus, about six times as long, sharply bent in middle, tapering evenly to point.

"Described from three females and one male from Ames, Iowa. Taken by the senior author August 5, 1895, on *Amorpha fruticosa,* and one male from Onaga, Kansas, July 9, 1898 (Crevecoeur), and five specimens from Ames, Iowa, in collection of Prof. Herbert Osborn. This is the stoutest species in the genus. It is much broader than *unipuncta,* which it otherwise resembles."

Type studied: Paratype, male, Ames, Iowa, August 5, 1895, Herbert Osborn collection (U. S. N. M.). Garnett, Kansas, July 7, 1933, P. W. Oman. Scott county, Arkansas, August 24, 1928 (on willow); Arkansas City, Kansas, June 12, 1935; R. H. Beamer.

This handsome species was chosen by Ball and DeLong as the genotype and displays admirably the genotypical features, though the curious structure of the aedeagus shows it to be somewhat removed phylogenetically from the rest of the species described.

16. *Alconeura nudata* Ball and DeLong

Alconeura unipuncta nudata Ball, E. D., and DeLong, D. M., Ann. Ent. Soc. Am., XVIII, 336, 1925.

Resembling *Alconeura rotundata* Ball and DeLong, but with apical dot on third vein, not in base of fourth cell; aedeagus with tonguelike ventromedian extension, without winglike processes at tip; pygofer process reduced to small rounded tooth.

Color. Creamy-white with orange-yellow markings. Vertex with inverted V in orange-yellow from apex to posterior margin, eyes narrowly bordered with yellow; pronotum with four orange-yellow

vittae, lateral pairs in males fused posteriorly; angles of scutellum orange and yellow. Forewing chiefly yellow, clavus almost entirely so; corium with two yellow vittae, diverging from humeral angle, one paralleling distal two thirds of claval suture, one along basal half of costal margin. Apical veins light with fulvous margins; apical dot on third vein. Tip of forewing darkened. Venter stramineous, often relieved with brighter yellow.

Genitalia. Aedeagus in lateral view more than six times as long as basal width; with pair of slender ventrolateral processes arising in basal third, paralleling shaft to tip, bending slightly ventrad at tips; median tonguelike extension lying between processes and shaft, reaching into apical fourth; tip of shaft projecting ventrad into short tooth. Pygofer process almost wanting, represented by very slight elevation.

"Described from five examples from Pasadena and San Francisco, California. Collected by the senior author."

The very short description given by Ball and DeLong was drawn apparently from exceptionally light specimens, and cannot be valued as truly representative of this brightly colored species, so very distinct from *Alconeura unipuncta* (Gillette). The description above was prepared from a pair of plesiotypes selected from a large series.

Types studied: Allotype, male, and paratype, female, San Francisco, California, September 9, 1907 (E. D. Ball collection). Plesiotypes, male and female, San Jacinto Mountains, California, July 21, 1929, R. H. Beamer. Haugan, Montana, August 9, 1931; Yellowstone Park, Frying Pan Lake, August 15, 1931; Grand Teton National Park, August 18, 1931; Mt. Shasta, California, June 29, 1935; Siskiyou N. F., California, July 14, 1935; Eureka, California, July 15, 1935; R. H. Beamer.

17. *Alconeura languida*, n. sp.

Resembling *Alconeura nudata* Ball and DeLong, but with lighter markings and less general yellowness; tips of paired ventrolateral processes on aedeagus and apical third of shaft bending abruptly dorsad.

Color. Creamy-white with orange-yellow markings. Vertex with orange inverted V, diverging lines almost parallel from apex to posterior margin; pronotum with four orange vittae; median pair continued across scutellum, apex of latter orange. Forewing with yellow vitta on clavus from near base almost to tip; corium with two yellow stripes, one paralleling claval suture from near humeral

angle almost to cross veins, one from base on costal margin halfway, briefly continuing obliquely inward along veins to transverse fumose mark. Apical veins yellow, fumosely outlined; apical dot in third cell, touching or upon third vein. Tip of forewing slightly darker. Venter stramineous.

Genitalia. Aedeagus in lateral view more than seven times as long as basal width; with pair of slender ventrolateral processes arising in basal third and attaining length of aedeagus, slightly sinuate, bending dorsad at tips; median tonguelike extension lying between processes and shaft, reaching past middle of and bending dorsad with apical third of shaft; tip of shaft recurving ventrad. Pygofer almost wanting, represented by toothlike projection, often appearing obliquely truncate.

Holotype, male; allotype, female; paratypes, twelve pairs; Chiricahua Mountains, Arizona, July 8, 1932. Huachuca Mountains, Arizona, July 8, 1932; Ashfork, Arizona, August 8, 1932; Yellowstone Park, August 15, 1932; Big Bear Lake, California, July 26, 1932; Flagstaff, Arizona, August 1, 1933; Santa Rita Mountains, Arizona, August 18, 1935; R. H. Beamer.

18. *Alconeura luculenta*, n. sp.

Resembling *Alconeura nudata* Ball and DeLong, but even more extensively yellow-colored and smaller; shaft of aedeagus with tip straight, not curving ventrad.

Color. Creamy-white, but largely obscured by broadening and fusing of orange-yellow markings. Vertex with orange-yellow inverted V joining orange-yellow lines bordering eyes at apical and posterior margins; pronotum with four orange-yellow vittae, these often quite broadly fused; scutellum with orange-yellow markings more or less fused. Forewing largely yellow, claval area completely so; corium with two very broad yellow stripes, one bordering claval suture almost to cross veins, other slightly separate, extending from humeral angle along costal margin to cross veins. Apical veins light, margined with fulvous; apical dot in third cell, touching or upon third vein. Tip of forewing slightly darkened. Venter yellow and brown; face bright yellow.

Genitalia. Aedeagus in lateral view more than seven times as long as basal width; with pair of slender ventrolateral processes arising in basal third, attaining length of aedeagus, tips bending slightly dorsad and abruptly recurving ventrad; median tongue-like extension between processes and shaft reaching past middle of apical third of shaft; tip of shaft straight. Pygofer process almost wanting, represented by rounded toothlike projection.

Holotype, male; allotype, female; paratype, male: Chiricahua Mountains, Arizona, July 8, 1932, R. H. Beamer. Additional paratypes: two males and twenty-two females, Ashfork, Arizona (on *Fallugia paradoxa*), June 30, 1933, P. W. Oman (U. S. N. M.). Wickenburg, Arizona, July 8, 1932; Las Cruces, New Mexico, June 8, 1933; R. H. Beamer. Organ, New Mexico, June 8, 1933, P. W. Oman.

19. *Alconeura cornigera*, n. sp.

Resembling *Alconeura luculenta*, n. sp., but with orange markings more definite; aedeagus divided into ventral and dorsal arms; pair of slender lateromedian processes reaching only into apical third of shaft; pygofer process hornlike, sharp-pointed, not simply a rounded tooth.

Color. Creamy-white with orange-yellow markings. Vertex with orange inverted V, lateral stripes parallel to posterior margin; pronotum with four irregular orange vittae, broadening posteriorly; scutellum orange, except anteromedian white rectangle. Forewing almost all yellow on claval area; corium with yellow stripe bordering distal two thirds of claval suture and one from humeral angle along costal margin almost to cross veins. Apical veins yellow, edged with fumose lines; apical dot in third cell, touching third vein. Tip of forewing slightly darker. Venter light yellow.

Genitalia. Aedeagus in lateral view more than three times as long as middle width; divided into ventral and dorsal arms, former curving to approach latter closely at tip; pair of slender pointed processes extending along sides from near base to distal third of shaft. Pygofer process about as broad at base as middle width of aedeagus and curving out almost into right angle, sides evenly converging to pointed tip.

Holotype, male: Huachuca Mountains, Arizona, August 1, 1927, R. H. Beamer.

Alconeura quadrivittata (Gillette)

Although specimens have not been taken in the United States, it should be noted here that Ball and DeLong (1925) place a species, described as *Dicranoura quadrivittata* by Gillette (1898), among the Alconeura.

McAtee (1926) makes the following note on the species: "Ball and DeLong have shown that the type locality for this species is Long Island, Bahamas. It needs only a glance at the figure of tegmen given by Gillette, or that of Ball and DeLong, to show how

slight a variation would serve to place the angulate but sessile third apical cell in the stalked category and thus give this species two stalked apical cells, a character which seems to be the only important one of the segregate *Kahaono* Kirkaldy. The type specimen has been available for the present study."

The third apical cell in the forewing of *Alconeura dodonana* Beamer is similarly angulate; this condition is quite variable, but simple angularity seems to be the extreme point in variation from the normal. There is at present no reason to conclude that it may be otherwise in *Alconeura quadrivittata* (Gillette), which is known only from the single male type now in the National Museum. While possibly confined to its island home, this troublesome species should be kept in mind by collectors in the more southern regions of the United States.

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ILLUSTRATIONS

Figures of the dissected male genitalia are presented in the specific order of the descriptions. It will be noted that the aedeagus has been pictured consistently with the ventral side toward the top of the page; this is believed the best position, since attention should be centered most on the ventral margin and its processes. The pygofer process in the position shown would lie below the other member of the pair if the illustration included both for each species.

The last two figures show the apeces of typical forewings, the apical cells and alternate positions of the apical dot.

PLATE XXIII

A: aedeagus; ventral margin upper. B: pygofer; inner margin upper.

FIG. 1. *Alconeura planata* Ball and DeLong.

FIG. 2. *Alconeura necopinata*, n. sp.

FIG. 3. *Alconeura beameri*, n. sp. A: Ventral view of tip of aedeagus.

FIG. 4. *Alconeura balli* Beamer. Line of measurement for basal width shown on aedeagus.

FIG. 5. *Alconeura tricolor* (Van Duzee).

PLATE XXIII

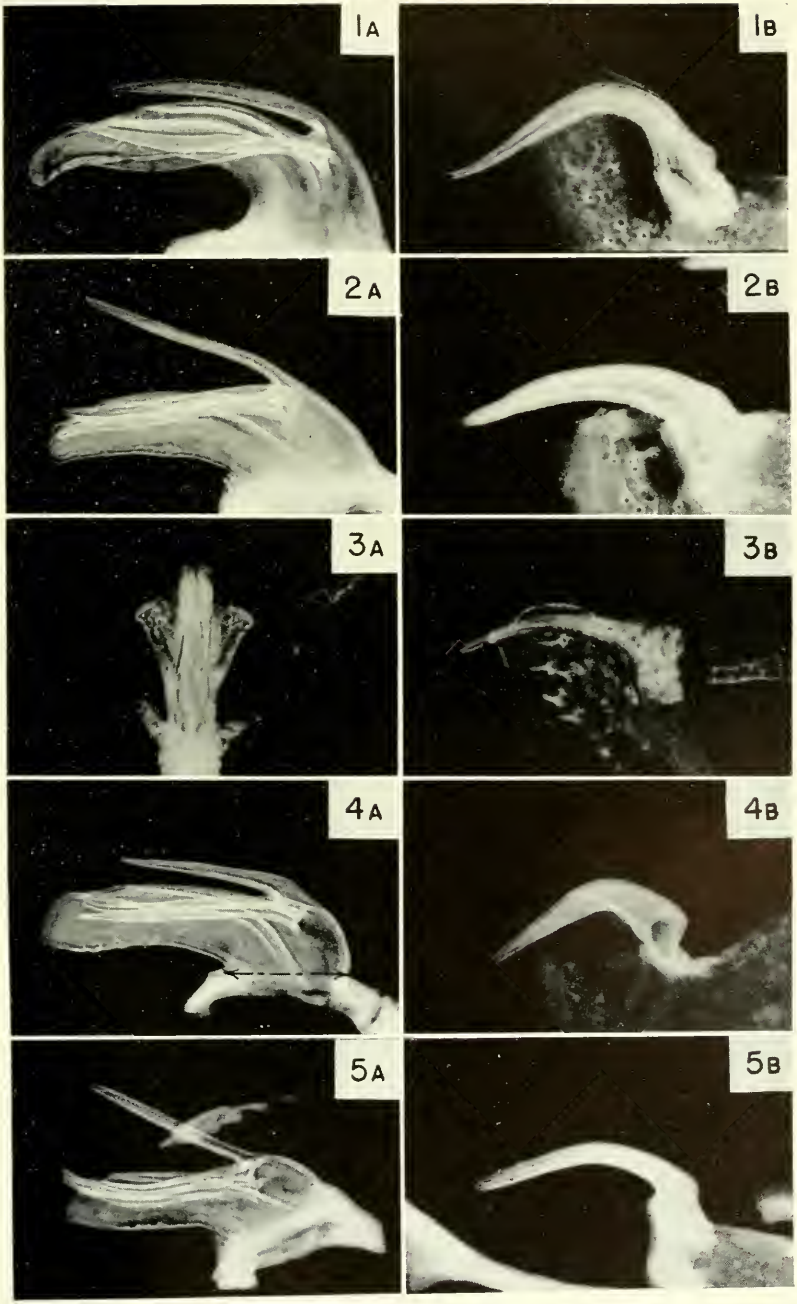


PLATE XXIV

A: aedeagus; ventral margin upper. B: pygofer; inner margin upper.
FIG. 6. *Alconeura fulminea* Lawson.
FIG. 7. *Alconeura dorsalis* (DeLong).
FIG. 8. *Alconeura unipuncta* (Gillette).
FIG. 9. *Alconeura quadrimaculata* Lawson
FIG. 10. *Alconeura derecta*, n. sp.

PLATE XXIV

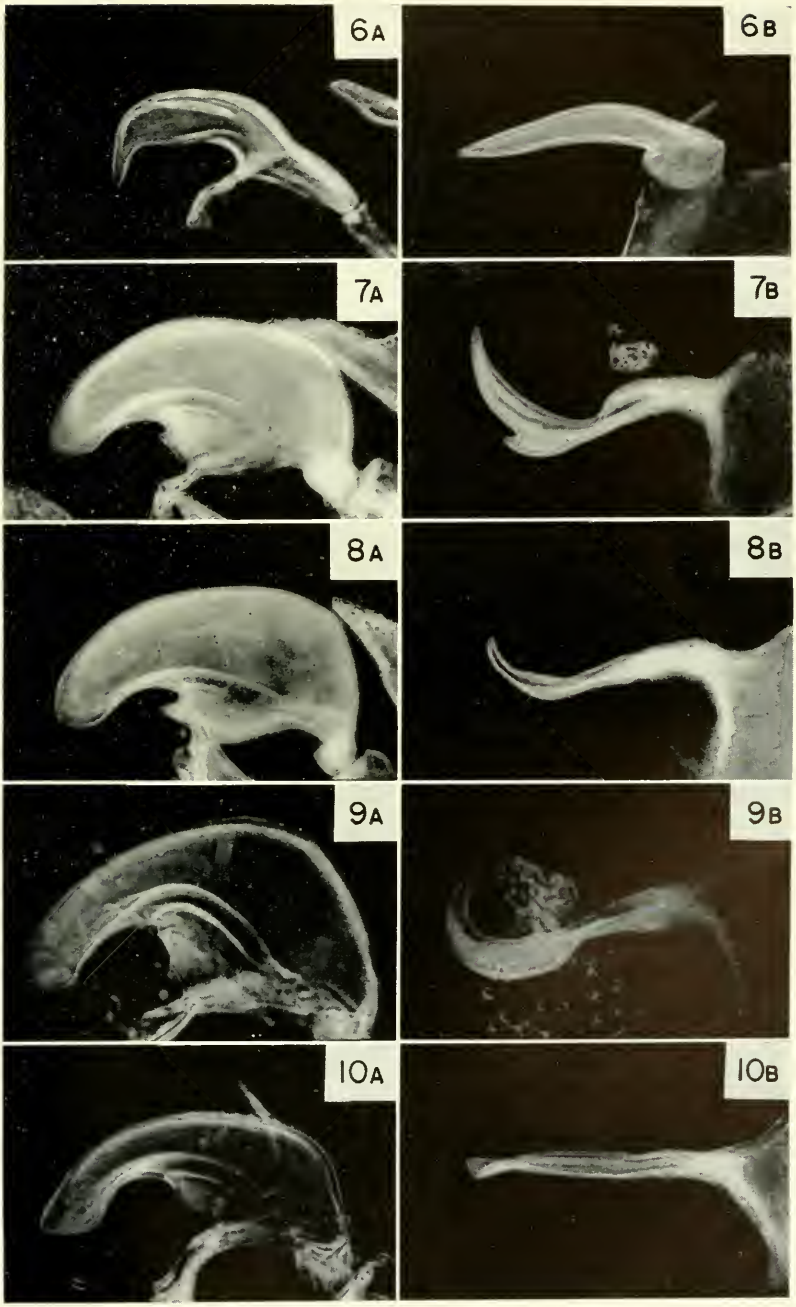


PLATE XXV

A: aedeagus; ventral margin upper. B: pygofer; inner margin upper.

FIG. 11. *Alconeura insulae,* n. sp.

FIG. 12. *Alconeura dodonana* Beamer.

FIG. 13. *Alconeura lappa,* n. sp.

FIG. 14. *Alconeura macra,* n. sp.

FIG. 15. *Alconeura rotundata* Ball and Delong. A: ventral view of tip of aedeagus.

PLATE XXV

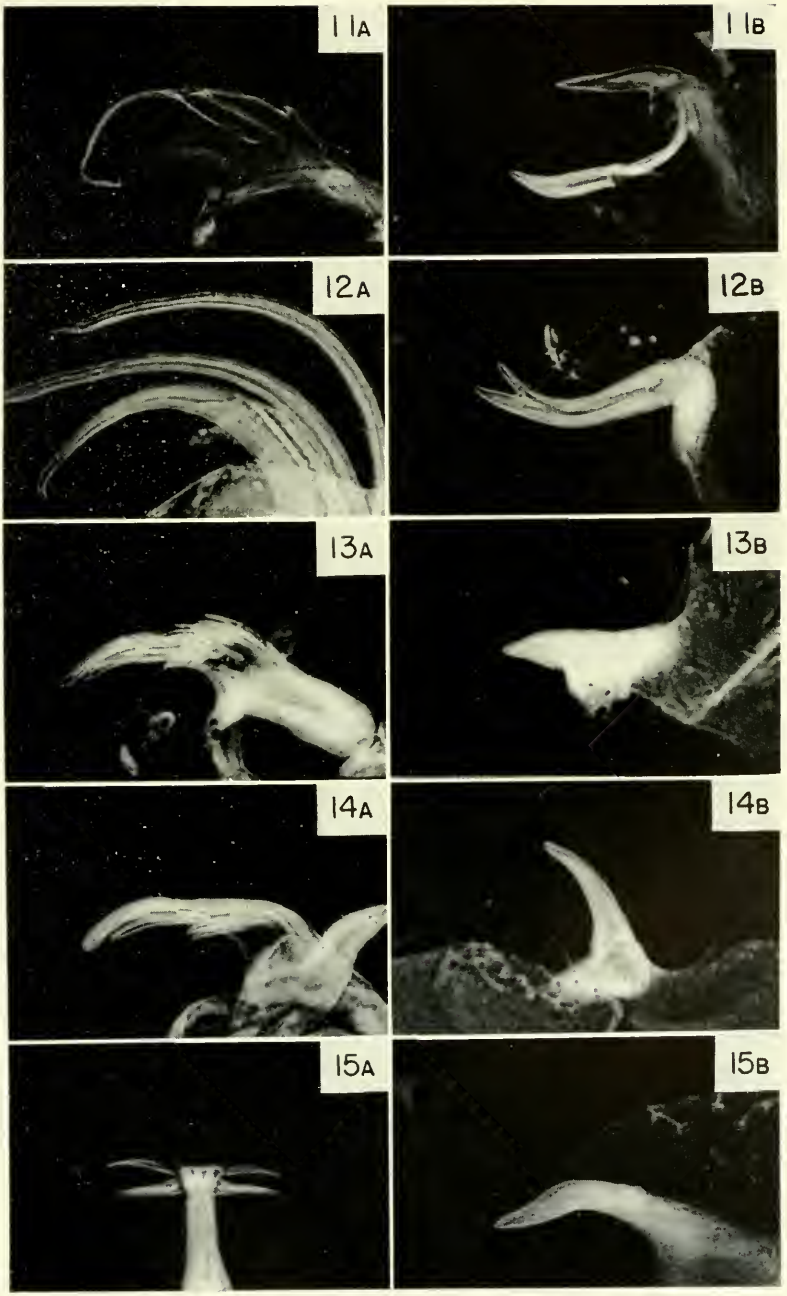


PLATE XXVI

A: aedeagus; ventral margin upper. B: pygofer; inner margin upper.

FIG. 16. *Alconcura nudata* Ball and DeLong.

FIG. 17. *Alconcura languida*, n. sp.

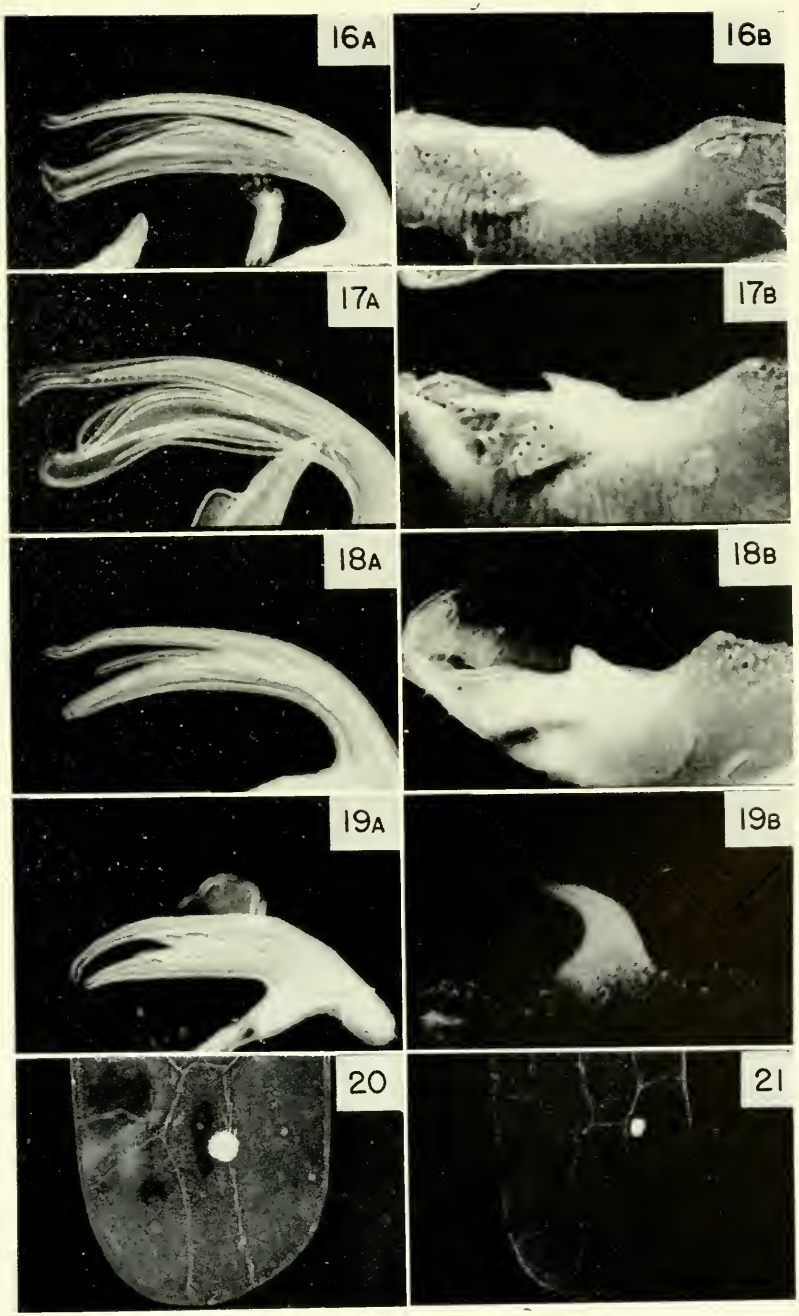
FIG. 18. *Alconcura luculenta*, n. sp.

FIG. 19. *Alconcura cornigera*, n. sp.

FIG. 20. *Alconcura quadrimaculata* Lawson. Apex of left forewing; from left to right: first, second (or pedunculate), third (or midapical), and fourth apical cells. The apical dot is in the third cell, partly lying upon the third vein.

FIG. 21. *Alconcura tricolor* (Van Duzee). Apex of left forewing; apical cells as in Fig. 20. The apical dot is in the base of the fourth cell.

PLATE XXVI



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A Generic Revision of American Bythoscopinae and South American Jassinae*

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ABSTRACT: The American genera of Bythoscopinae and the South American genera of Jassinae are reviewed. A key to the American subfamilies of Cicadellidae, and keys to the genera of the subfamilies indicated are included, as well as drawings illustrating the head structures and wing venation of the genotypes of most of the genera treated. Taxonomic terminology for leaf hoppers is discussed and some new terms introduced. The new categories described and nomenclatorial changes made are as follows. New genera: *Euragallia* (type, *Agallia furculata* Osborn), *Agalliota* (type, *Agallia punctata* Oman), *Brasa* (type, *Macropsis rugicollis* Dozier), *Neopsis* (type *Pediopsis elegans* Van Duzee), *Bythonia* (type *Nionia* (?) *rugosa* Osborn), *Cariancha* (type *Cariancha cariboba*, n. sp.), *Brincadorus* (type *Brincadorus laticeps*, n. sp.), *Cerrillus* (type *Hecalus notatus* Osborn), *Arrugada* (type *Huleria rugosa* Osborn), *Egenus* (type *Egenus acuminatus*, n. sp.), *Bonamus* (type *Bonamus lineatus*, n. sp.), *Bolarga* (type

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Parabolocratus bolivianus Osborn), *Garapita* (type *Garapita garbosa*, n. sp.), *Agudus* (type *Agudus typicus*, n. sp.), *Cumora* (type *Cumora angulata*, n. sp.), *Kanorba* (type *Kanorba reflexa*, n. sp.), *Caphodus* (type *Caphodus maculatus*, n. sp.), *Baroma* (type *Baroma reticulata*, n. sp.), *Bahita* (type *Eutettix infuscata* Osborn), *Atanus* (type *Eutettrix dentatus* Osborn), *Hegira* (type *Hegira brunnea*, n. sp.), *Faltala* (type *Faltala brachyptera*, n. sp.), *Brazosa* (type *Thamnotettix picturellus* Baker), *Alaca* (type *Alaca longicauda*, n. sp.), *Onura* (type *Onura eburneola*, n. sp.), *Benala* (type *Deltocephalus tumidus* Osborn), *Cortona* (type *Cortona minuta*, n. sp.), *Agelina* (type *Agelina punctata*, n. sp.), *Neobala* (type *Thamnotettix pallidus* Osborn), *Conala* (type *Spangbergiella fasciata* Osborn), and *Coelidiana* (type *Neocoelidia rubrolineta* Baker). New subgenera: *Acceratagallia* (*Bergallia*) (type *Bythoscopus signatus* Stal), *Deltocephalus* (*Haldorus*) (type *Thamnotettix ventaus* Osborn). New synonymy: *Bythoscopus Germar* (=*Eurinoscopus* Kirkaldy); *Pachyopsis* Uhler (=*Straganiopsis* Baker); *Pachyopsis lactus* Uhler (=*Macropsis idiocroides* Baker); *Spangbergiella* Signoret (=*Bergiella* Baker); *Bolarga bolivianus* (Osborn) (=*Bolarga bolivianus* var. *pallida* Osborn); *Nesosteles* Kirkaldy (=*Anomiana* Distant); *Nesosteles incisus* Matsumura (=*Euguathodus lacteus* Baker, =*Euguathodus bisinuatus* DeLong, =*Euguathodus pallidus* Osborn, =*Euguathodus bifurcatus* DeLong and Davidson, =*Nesosteles arcolata* Osborn, and =*Nesosteles tutuilana* Osborn). Changes in generic assignment of species, other than that indicated in the designation of genotypes and in the new synonymy: *Huleria affinis* Osborn transferred to *Arrugada*; *Scaphoideus mexicanus* Osborn from *Portanus* to *Osbornellus*; *Scaphoideus boliviensis* Baker, *S. hasemani* Baker, and *S. longicornis* Osborn to *Portanus* Ball; *Platymetopius longiceps* Berg to *Agudus* Oman; *Eutettix neocinctus* Osborn, *E. elegans* Osborn, and *Mesamia fasciata* Osborn to *Menosoma* Ball; *Jassus palliditarsus* Stal, *Eutettix irroratus* Osborn, *E. femoratus* Osborn, *E. laticeps* Osborn, and *Aligia plena* Van Duzee to *Bahita* Oman; *Eutettix tessellatus* Osborn and *Thamnotettix lobatus* Osborn to *Atanus* Oman; *Euscelis quadratulus* Osborn, *E. pallida* Osborn, *Athysanus digressus* Van Duzee, *Thamnotettix capicola* Stal, *Athysanus fusconervosus* Motschulsky, *Jassus taeniaticeps* Kirschbaum, *Athysanus indicus* Distant, *A. nanus* Distant, *A. atkinsoni* Distant, *A. simillimus* Matsumura, and *A. transversalis* Matsumura to *Exitianus* Ball; *Thamnotettix amazonensis* Osborn to *Brazosa* Oman; *Agallia multipunctata* Osborn to *Alaca* Oman; *Thamnotettix luteosus* Baker to *Chlorotettix* Van Duzee; *Cicadula maidis* DeLong and Wolcott to *Baldulus* Oman; *Euscelis quadrimaculata* Osborn, and *Thamnotettix guaporensis* Oman to *Neobala*; *Neocoelidia bimaculata* Baker, *N. modesta* Baker, *N. inflata* Osborn, and *N. croceata* Osborn to *Coelidiana* Oman; *Neocoelidia smithii* Baker to *Chinaia* Bruner and Metcalf. *Idiocerus* Lewis is placed in the Eurymelinae, *Ionia* Ball in the Bythoscopinae and *Chinaia* Bruner and Metcalf in the Jassinae. *Pachyopsis* Uhler is removed from synonymy. *Ionia* Ball is considered as a subgenus of *Acceratagallia* Kirkaldy, and *Deltopinus* Ball, *Cloanthus* Ball, *Nasutoideus* Ball, and *Convelinus* Ball are considered as subgenera of *Scaphytopius* Ball. Types of the new species are in the collection of the United States National Museum.

INTRODUCTION

FOR over a century and a half workers in taxonomic entomology have been contributing to our knowledge of the Cicadellidae or leaf hoppers of South America. Most of these contributions have been concerned primarily with the description of new species, these being assigned to the then established European or North American genera known to the describer. Although a great deal of work has been done in recent years on the proper differentiation of the North American genera, the proper assignment of the South American representatives of these groups has not kept pace, and what few genera have been erected for South American forms have in most cases been based on unusual and phylogenetically isolated species, so that their erection adds little to a natural arrangement of the more complex portions of the higher groups. Consequently, the accepted limits of the established genera have been so enlarged by the inclusion of many species representing diverse evolutionary trends that these heterogeneous groups cannot be defined and become useless as a basis for classification. It is similarly impossible to use the mass of specific descriptions as a basis for the identification of species in the group, and it becomes evident that before any appreciable order can be brought from the confusion that exists, genera must be defined, keys presented for the separation of those genera, and the previously described species referred to their correct generic positions. The present paper is an attempt to do this for the subfamilies indicated, but in many cases the assignment of previously named species to their respective genera has been impossible, owing to the lack of adequate descriptions, and must await the examination of types or authentically determined specimens.

At the time this study was undertaken it was the intention of the writer to limit it to the South American fauna, but the North American Bythoscopinae were treated also when it became apparent that they could be included without greatly enlarging the paper. The writer realizes the inadequacy of a restricted fauna as a basis for a generic revision, and has endeavored to eliminate errors as far as possible by constant reference to literature and collections dealing with other faunal regions. In this he has been particularly fortunate in having available for study genotypes of most of the European, Philippine, and Australian genera and a consider-

able number of African and Indian species. Generic concepts here presented have been based primarily on the study of genotypes, plus as many other species as were available. If authentically determined material of the type species of a genus has not been available for study it is so stated in the discussion of the genus.

ACKNOWLEDGMENTS

The preparation of this paper has been expedited by the ready assistance given by various entomological workers. Expression of gratitude is made to Dr. R. H. Beamer, of the University of Kansas, under whose direction the major portion of the work was undertaken and who has assisted much with notes and suggestions; to Mr. H. G. Barber, of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, who has given freely of his time for the discussion of problems of common interest to hemipterists; to Mr. R. E. Snodgrass, of the same bureau, for the generous assistance in problems of a morphological nature; to Dr. E. D. Ball, of the University of Arizona, for valued suggestions concerning taxonomic terminology; to Mr. E. P. Van Duzee, of the California Academy of Sciences, for kind suggestions and encouragement; to Dr. Hugo Kahl, curator of insects at the Carnegie Museum, for many kindnesses while the writer was working at that institution, and for the loan of valuable material; to Mr. C. H. Ballou, of Costa Rica, for specimens of *Chinaia bella* Bruner and Metcalf; to Mr. J. N. Knull, curator of insects at Ohio State University, for the loan of valuable material and for notes and drawings of other material not available to the writer.

MORPHOLOGICAL NOTES AND TERMINOLOGY

The writer makes no attempt in the present paper to enter into a detailed discussion of the morphology of the Cicadellidae, but proposes merely to define the terms used and to illustrate the structures mentioned sufficiently to permit the user of the paper to interpret correctly and easily the verbal descriptions of the writer. A necessity for so doing has arisen through the introduction of a few terms new to the literature on Homoptera, and the adoption of others that have been little used by taxonomic workers. The choice of terms has been made only after careful consideration of the needs of the taxonomist, recognizing that for the purpose of writing intelligible and at the same time reasonably brief descriptions, terminology borrowed from morphological workers is frequently unsatisfactory.

According to recent work on the insect head by Snodgrass, 1935 (pp. 111, 329-331), the frons in the Cicadellidae is greatly reduced and not evident as a distinct area. The area previously referred to by most workers as frons, is, according to Snodgrass, the postclypeal plate, while the clypeus of certain authors is the anteclypeal plate of Snodgrass. The writer has chosen, for taxonomic work, to restrict the term clypeus to the postclypeus of Snodgrass and use the term clypellus for his anteclypeus (Pl. XXVII, fig. 1B). The clypeus and clypellus together constitute the front. The entire cephalic aspect of the head is referred to as the face (Pl. XXVII, fig. 1B), and the area between the eye and the adjacent ocellus, or between the eye and the lateral frontal suture, if it is present, is referred to as the ocellocular area. The entire dorsal surface of the head, exclusive of the eyes, is called the crown (Pl. XXVII, fig. 1C).

In referring to the veins of the wings, the Comstock-Needham system has been followed with the now generally accepted emendations, as indicated (Pl. XXVII, figs. 1 and 1A), and certain other modifications in naming which are now well established in literature. The forewing of leaf hoppers normally has a basal cross vein between media and cubitus, called the first cross vein, and frequently has a second cross vein in the region at the base of the central anteapical cell. The claval suture appears to be cubitus 2, but the name claval suture is here retained. For the cells of the wings the writer has retained the well-established terms in use with but few additions. The anteapical cells, typically three in number, are designated inner, central, and outer, respectively, beginning nearest the claval suture, and the inner is considered as being present even though the second cross vein between M and Cu is absent, in which case the cell remains open basally. Similarly these cells are considered as distinct entities even though divided by extra cross veins. The apical cells, for purposes of stability in naming, are numbered from the inner margin of the wing outward, the third apical cell thus always having its base at the distal end of the central anteapical cell.

CHARACTERS OF THE SUBFAMILIES

The following key is presented for the separation of the subfamilies of Cicadellidae known to occur in America.

1. Ocelli situated near disk of crown, remote from eyes and from anterior margin of crown 2

   Ocelli on or near distal margin of crown, or on face, or absent 3

2. (1) Lateral frontal sutures extending over obtuse anterior margin of crown to vicinity of ocelli. Hind wing usually with submarginal vein evanescent from hamulus to apex, leaving only three apical cells. Form usually somewhat cylindrical, not flattened ..... Cicadellinae

Lateral frontal sutures terminating below anterior margin of crown, which is usually distinct. Hind wing always with four apical cells. Form flattened dorsoventrally ..... Gyponinae

3. (1) Ocelli on face, which is separated from crown by a distinct margin....Koebelinae

Ocelli either on face or not, or absent, but if on face, then face and crown not separated by a distinct margin 4

4. (3) Lateral frontal sutures terminating at or slightly above antennal pits. Intermediate tibiae without numerous large, spinelike setae .....Bythoscopinae

Lateral frontal sutures extending above antennal pits to or near ocelli or ocellar vestiges. Intermediate tibiae usually with numerous large, spinelike setae.... 5

5. (4) Distance between ocelli less than distance between antennal pits. Face broad and relatively flat, crown always short and broad. Ocelli always on face. Eurymelinae

Distance between ocelli or ocellar vestiges equal to or greater than distance between antennal pits. Face usually not especially flat, crown of various shapes. Ocelli on or near margin between crown and face or absent 6

6. (5) Forewings usually with cross veins anterior to the apical series. Veins distinct basally; ocelli usually present. Facial sclerites not highly fused, lori not particularly elongated .....Jassinae

Forewings usually without cross veins anterior to the apical series. Veins indistinct basally; ocelli often absent. Faciae sclerites showing a high degree of fusion, lori unusually long and narrow. Small, fragile forms, usually brightly colored .....Eupteryginae

In the consideration of the leaf hopper fauna of the entire world, or even that of one of the major faunal regions, it soon becomes evident that the differentiation of subfamilies is an extremely difficult task. Consequently, the writer freely admits that the key presented above is unsatisfactory in some respects, but feels that it is better to attempt to key out intermediate forms with the use of somewhat indefinite characters, or a combination of characters, than to ignore such forms and use brief but positive alternatives.

Idiocerus and allies have been removed from the Bythoscopinae, with which they have little in common, and referred to the Eurymelinae. This will at first seem to be an erroneous disposition of the group, since Eurymela shows so many cercopid-like characters, but a study of species of Eurymeloides, Churna, and other Australian and Oriental genera convinces the writer that the arrangement is a natural one.

Kirkaldy, 1906 (p. 345), McAtee, 1934 (p. 94), and perhaps others have pointed out that the much-used character of the position of the ocelli or ocellar vestiges is not a sufficient basis for the separation of the Jassinae and Bythoscopinae. McAtee proposes to base the separation on the development of the bristles or spines on the lower surface of the fore tibiae, but the writer believes this to be even less reliable than the position of the ocelli. The separation here proposed is indicated in the preceding key. In addition to the characters indicated, the transverse suture on the scutellum is usually curved forward laterally in the bythoscopines and backward in the jassines, although this is by no means a reliable character.

According to the above interpretation it has been found necessary to place *Ionia* Ball in the Bythoscopinae as a relative of Ceratagallia and to transfer *Chinaia* Bruner and Metcalf from the Bythoscopinae to the Jassinae, where it is closely related to Jassus and allies. The writer has been unable satisfactorily to place *Dicyphonia picturata* Osborn, 1924, but feels certain that the assignment of the species to the genus *Dicyphonia* Ball is erroneous.

KEY TO THE AMERICAN GENERA OF BYTHOSCOPINAE

1. Lateral margins of pronotum carinate and moderately long. Form distinctly depressed. First apical cell of forewing very narrow. Ledges above antennal sockets transverse or nearly so 11

   Lateral margins of pronotum short and not carinate. Form often broad but not depressed. First apical cell of forewing normal. Ledges above antennal sockets, when present, always oblique 2

2. (1) Hind wing with three apical cells. Distance between ocelli equal to, or usually greater than, twice the distance from ocellus to eye..... 9

   Hind wing with four apical cells. Distance between ocelli not over twice distance from ocellus to eye 3

3. (2) Distance between ocelli equal to or less than distance from ocellus to eye. Lateral margins of genae not distinctly sinuated below eyes 8

   Distance between ocelli always greater than distance from ocellus to eye. Lateral margins of genae usually distinctly sinuated below eyes 4

4. (3) Surface of pronotum finely granulated, neither coarsely pitted nor transversely rugulose 6

   Surface of pronotum either coarsely pitted or transversely rugulose 5

5. (4) Surface of pronotum transversely rugulose .....*Accratagallia*, p. 350

   Surface of pronotum coarsely pitted.....*Agalliana* p. 350

6. (4) Posterior margin of crown sinuately curved laterally and crown distinctly extended laterally behind eye. Length of crown medially usually less than next the eye. Eyes never bulbous .....*Agalliopsis*, p. 351

   Posterior margin of crown smoothly rounded with only a narrow lateral extension behind eye. Length of crown uniform, or, if shorter medially, eyes somewhat bulbous 7

7. (6) Crown shorter medially than eyes; eyes somewhat bulbous. Face rather flat, pronotum short. Seventh ventral segment of female short and exposing underlying membranes, styles of male genitalia not forked or with forks obsolete .....*Euragallia*, p. 351

   Crown of uniform length. Face distinctly convex, pronotum longer in proportion to width. Genital characters not as above .....*Agallia*, p. 351

8. (3) Forewing at least partly membranous, tapering apically. Pronotum and scutellum not distinctly elevated or "humped" in profile.....*Agalliota*, p. 351

   Forewing entirely opaque and subcoriaceous, broad apically. Pronotum and scutellum distinctly elevated or "humped" in profile .....*Brasa*, p. 352

9. (2) Hindwing with inner fork of radius and outer fork of media united apically (Pl. XXVII, fig. 2A); submarginal vein present between hamulus and apex of wing .....*Neopsis*, p. 353

   Hind wing with forks of veins not united apically; submarginal vein evanescent from hamulus to apex of apical cells (Pl. XXVII, fig. 4)..... 10

10. (9) Pronotal striae transverse; anterior margin of pronotum broadly rounded, *Oncopsis*, p. 353

    Pronotal striae oblique, converging anteriorly; anterior margin of pronotum angulate medially .....*Macropsis*, p. 352

11. (1) Hind wing with three apical cells (Pl. XXVII, fig. 2A). Inner apical margin of forewing and first apical cell membranous and appendix-like, frequently bent down at a distinct angle to remainder of wing, *Bythoscopus*, p. 353

    Hind wing with four apical cells. Inner apical cell of forewing not as above. *Pachyopsis*, p. 354

DESCRIPTIONS OF BYTHOSCOPINE GENERA

Aceratagallia Kirkaldy*

Aceratagallia Kirkaldy, Hawaiian Sugar Planters' Assoc. Expt. Sta., Div. Ent. Bull. 3, p. 30, 1907.

Type of the genus, *Bythoscopus sanguinolentus* Provancher, 1872 (p. 376), a Nearctic species. As defined in the key, this genus occurs in the Nearctic, Neotropical, Palearctic, and Oriental regions. The typical forms, referred to the subgenus Aceratagallia, are known only from North America.

The typical forms of the genus, and those belonging to the other two subgenera, may be differentiated by the following key:

1. Styles of internal male genitalia forked. South America..... *Bergallia*
   Styles of internal male genitalia not forked. North America..... 2
2. (1) Very small, extremely robust species, ocelli visible from above. Color, reddish-brown ..... *Ionia*
   Larger and less robust species, the ocelli not visible from above. Color usually some shade of fuscous, brown, or cinereous, never reddish-brown, ... *Aceratagallia*

Aceratagallia subgenus *Ionia* Ball

Ionia Ball, Bull. Brooklyn Ent. Soc., vol. 28, p. 226, 1933.

Type of the subgenus, *Ionia triunata* Ball, 1933. This is the only known representative of the subgenus. The writer does not consider the difference in size and position of the ocelli sufficient basis for treating Ionia as distinct from Aceratagallia, with which it agrees in having the frontal sutures terminating at the antennal sockets, a transversely striated pronotum, and typical aceratagallian genitalia in the males.

Aceratagallia subgenus *Bergallia*, new subgenus

Type of the subgenus, *Bythoscopus signatus* Stål, 1859, a Neotropical species known only from Argentina. This subgenus is erected to accommodate the South American representatives of Aceratagallia.

Agalliana Oman

Agalliana Oman, U. S. Dept. Agr. Tech. Bull. 372, p. 70, 1933.

Type of the genus *Bythoscopus sticticollis* Stål, 1859 (p. 291), a Neotropical species. The genus is apparently limited in distribution to the Neotropical region, and is known to include, in addition to the genotype, *Agalliana grossa* Oman, *ensigera* Oman, *fusca* Oman, and *ancora* Oman, 1934.

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* The writer is treating the American genera of the *Agallia* group in detail in a forthcoming publication and considers it unnecessary to include complete descriptions here.

Agallia Curtis

Agallia Curtis, Ent. Mag., vol. 1, p. 193, 1833.

Type of the genus, *Agallia consobrina* Curtis, 1833, which is at present considered to be a synonym of *Jassus punctiveps* Germar, 1832 (fasc. 17, p. 2), a Palearctic species. The genus (*sensus strictus*) is known to occur commonly in the Palearctic, Nearctic, and Neotropical regions, and possibly also in the Oriental region, although a careful study of the Oriental species may reveal characters which will justify generic segregation.

Euragallia, new genus

Type of the genus, *Agallia furculata* Osborn, 1923, a Neotropical species. So far as known the genus is limited in distribution to the Neotropical region. Euragallia bears a superficial resemblance to *Moonia* Distant, type, *Moonia saneita* Distant, 1908, from British India, but differs in the position of the ocelli, the shape of the pronotum, and other pertinent characters, and is more closely related to *Agallia* Curtis.

Agalliopsis Kirkaldy

Agalliopsis Kirkaldy, Hawaiian Sugar Planters' Assoc. Expt. Sta., Div. Ent. Bull. 3, p. 31, 1907.

Type of the genus, *Jassus novellus* Say, 1831, an American species. The genus is apparently limited in distribution to the Nearctic and Neotropical regions.

Agalliopsis bears a distinct resemblance to *Nehela* Buchanan White, type *Nehela vulturiana* Buchanan White, 1878, from St. Helena (synonym, *Igerna* Kirkaldy, 1903 [*Pachynus* Stål, 1866, not *Pachynus* Bonaparte, 1854], type *Bythoscopus* (*Oncopsis*) *bimaculaticollis* Stål, 1855), but that genus has the ocelli close together, and although the crown extends laterally behind the eyes, it is not shortened medially. *Nehela* appears to be more closely related to *Agallia* Curtis.

Agalliota, new genus

Type of the genus, *Agallia punctata* Oman, 1934, a Neotropical species. So far as known the genus is limited in distribution to the Neotropical region.

Brasa, new genus

(Pl. XXVIII, fig. 1)

Resembling *Macropsis* Lewis in general form, but more closely related to *Agallia* Curtis by the venation of the hind wing. Differing from Macropsis in having four apical cells in the hind wing and in having no pronotal striations, and from Agallia and related genera by the position of the ocelli, which are close together, the broad forewings, and the "humped" appearance of the thorax.

Crown very short and of uniform length. Face slightly convex, frontal sutures distinct, genae broad. Pronotum several times as long as vertex, lateral margins obsolete, disk and posterior portion strongly elevated, anterior margin with depressed areas behind eyes. Scutellum distinctly elevated above forewings, especially anteriorly. Forewing opaque and subcoriaceous, nearly flat and held in a nearly vertical position as in *Macropsis*, apex broad and rounded, appendix very small or absent, closed anteapical cells two in number.

Type of the genus, *Macropsis rugicollis* Dozier, 1926 (p. 264), known only from the island of Haiti. No other species known to the writer belong in the genus.

Macropsis Lewis

Macropsis Lewis, Trans. Ent. Soc. Lond., vol. 1, p. 49, 1836.

Pediopsis Burmeister, Gen. Ins., pl. 10, 1838. (Type, *Jassus tiliae* Germar, 1831, a Palearctic species now known to occur in the northeastern part of the United States.)

Galboa Distant, Trans. Linn. Soc. Lond., vol. 13, pp. 45-46, 1909. (Type *Galboa typica* Distant, 1909, from Seychelles.)

Crown very short, angled medially. Face convex, lori and genae small and indistinctly separated from each other and from front. Pronotum several times as long as vertex, pronotal striae distinct and oblique, converging anteriorly. Scutellum large. Forewing sometimes subcoriaceous, appendix very small or absent. Last ventral segment of female with lateral points of attachment very short, posterior margin with only faint notches and few modifications useful in specific separation. Male plates long, slender, and fingerlike.

Type of the genus, *Cicada virescens* Gmelin, 1788 (p. 2111), a Palearctic species now known to occur in the Nearctic region also. As here considered the genus is known to be distributed throughout the world with the exception of South America. Typical species are particularly abundant in the Nearctic and Palearctic regions. *Galboa* Distant is included as a synonym on the authority of China, 1925.

Oncopsis Burmeister

(Pl. XXVII, fig. 4)

Oncopsis Burmeister, Gen. Ins., pl. 10, 1838.

Crown short and broad, not angled as in Macropsis. Clypeus more convex than in Macropsis and face shorter and broader. Pronotum with striae transverse, but usually not so coarse as those of Macropsis. Forewings broad apically, appendix absent. Genitalia as in Macropsis.

Type of the genus, *Cicada flavicollis* Linnaeus, 1761 (p. 891), a Palearctic species. So far as known the genus is limited in distribution to the Nearctic and Palearctic regions.

Neopsis, new genus

Intermediate in character between *Macropsis* Lewis and *Bythoscopus* Germar; related to the former by the shape of the pronotum and head, and resembling the latter in the venation of the hind wing. Differing from Macropsis in having the inner fork of the radius and the outer fork of the media of the hind wing anastomosing distally, and from Bythoscopus in having the lateral pronotal margins obsolete and without carinae.

Crown short and rounded to the front, subangular medially as in Macropsis. Clypellus small, genae comparatively narrow. Pronotum several times as long medially as median length of vertex, surface with numerous fine, nearly transverse striae. Forewing tapered distally, not broad as in Macropsis, venation irregular and difficult to see, the normally central anteapical cell apparently open basally, appendix absent. Genitalia of both sexes differing from the conventional Macropsis type.

Type of the genus, *Pediopsis elegans* Van Duzee, 1907 (p. 58), described from Jamaica and known to occur in South America. No other species are referred to the genus.

Bythoscopus Germar

(Pl. XXVII, fig. 2, 2A)

Bythoscopus Germar, Silb. Rev. Ent., vol. 1, p. 180, 1833.

Batracomorphus Lewis, Trans. Ent. Soc. Lond., vol. 1, p. 31, 1836. (Type, *Batracomorphus irroratus Lewis*, 1836, a Palearctic species.)

Stragania Stal, Rio Jan. Hemip., vol. 2, p. 49, 1862. (Type, *Stragania ornatula* Stal, 1862, a Brazilian species.)

Gargaropsis Fowler, Biol. Cent. Amer. Homop., vol. 2, p. 167, 1896. (Type, *Gargaropsis innervis* Fowler, 1896, a Mexican species.)

Eurinoscopus Kirkaldy, Hawaiian Sugar Planters' Assoc. Expt. Sta., Div. Ent. Bull. 1, p. 346, 1906. (Type, *Eurinoscopus lentiginosus* Kirkaldy, 1906, an Australian species.) (New synonymy.)

Crown short and broad, but distinctly longer in proportion to its length than that of most genera of the subfamily. Crown, pronotum, scutellum, and portions of face usually with fine, transverse striae. Face very short and broad, clypellus but slightly longer than broad, lateral margins of genae strongly sinuated. Forewings with surface usually thickly set with fine setae, sometimes subcoriaceous. Male plates usually covered by the unusually large valve.

Type of the genus, *Cicada lanio* Linnaeus, 1761 (p. 892), a Palearctic species. The genus appears to be practically cosmopolitan in distribution and is represented in North America by a number of species. South American species referred to the genus include *Stragania ornatula* Stål, *S. divisa* Stål, and *S. pallescens*, Stål, 1862; *Macropsis smithii* Baker, *M. sordidus* Baker, and *M. stramineus* Baker, 1900; *Bythoscopus pallidus* Osborn and *B. nigrifrons* Osborn, 1924; and will probably contain some other species described by Stål.

The writer has examined the genotype of *Eurinoscopus* Kirkaldy and is of the opinion that the additional elytral cross veins which he mentions in his description are not sufficient basis for retaining that genus as distinct from Bythoscopus.

Pachyopsis Uhler

(Pl. XXVII, fig. 3)

Pachyopsis Uhler, Bull. U. S. Geol. Geog. Surv., vol. 3, p. 466, 1877.

Straganiopsis Baker, Invert. Pacif., vol. 1, p. 10, 1903. (Type, *Macropsis idioceroides* Baker, 1900, which is at present considered to be a synonym of *Pachyopsis laetus* Uhler, 1877.) (New synonymy.)

The genus is here removed from synonymy, having previously been considered a synonym of *Bythoscopus* Germar. Characters of diagnostic value are given below.

Closely related to *Bythoscopus* Germar, with which it has been placed, but differing from that genus in having four apical cells in the hind wing, and in having the face less strongly receding.

Characters of the head and pronotum as in Bythoscopus except that the clypellus is broader and the lateral margins of the pronotum are shorter and less diverging posteriorly. Forewing with a small appendix or none, inner apical cell not membraneous as in *Bythoscopus*.

Type of the genus, *Pachyopsis laetus* Uhler, 1877, a Nearctic species, known to occur only in the southwestern part of the United States. The genus will also contain, in addition to *Macropsis laetus* var. *pactus* Ball, 1900, an apparently undescribed species from Panama and two South American species.

KEY TO THE SOUTH AMERICAN GENERA OF JASSINAE

1. Second cross vein of forewing joining media anterior to base of central anteapical cell (Pl. XXVIII, fig. 2); apex of forewing rounded, appendix small. Second apical cell of hind wing very narrow. Head extremely short and broad, ocelli distant from the eyes (Pl. XXXI, fig. 1), *Bythonia*, p. 358

Second cross vein of forewing, if present, joining central anteapical cell (except in *Idiotettix*, which has the forewing subtruncate apically and the appendix very large). Second apical cell of hind wing rarely narrow. Width of head and position of ocelli variable 2

2. (1) Head, thorax, and at least basal portions of forewings with numerous circular pits. Hind wing with apical margin concavely excavated opposite third and fourth apical cells (Pl. XXVIII, fig. 3). Color black ..... *Nionia*, p. 358

Head, thorax, and forewings without distinct circular pits. Apex of hind wing convexly rounded. Color variable, seldom black 3

3. (2) Submarginal vein of hind wing evanescent or joining wing margin opposite apical cells (Pl. XXVIII, fig. 4A). Forewing without appendix, *Xestocephalus*, p. 359

Submarginal vein of hind wing present and not joining wing margin apically. Forewing either with or without appendix 4

4. (3) Head and anterior portion of pronotum coarsely and irregularly rugose (Pl. XXXI, fig. 7) ..... *Arrugada*, p. 362

Head and pronotum not as above 5

5. (4) Costal area of hind wing much expanded for a short distance near base (Pl. XXX, fig. 9A). Forewing always broad 56

Costal area of hind wing not expanded basally. Forewing either broad or narrow 6

6. (5) Ocellocular area produced into a distinct ledge above the antennal socket, 51

Ocellocular area not produced into a ledge above antennal socket 7

7. (6) Cubitus of forewing appearing forked* near first cross vein (Pl. XXVIII, fig. 7). Forewing never with more than one closed anteapical cell and usually only one claval vein ..... *Spangbergiella*, p. 364

Forewing not as above 8

8. (7) Forewing acuminate distally and without appendix (Pl. XXVIII, fig. 6). Crown flat and anterior margin carinate ..... *Egenus*, p. 363

Forewing not acuminate, or if so, then crown neither flat nor carinate anteriorly 9

9. (8) Forewing with two closed anteapical cells, the outer short and subtriangular, the central strongly constricted; appendix lacking (Pl. XXVIII, fig. 9). Crown broad and flat, with anterior margin carinate ..... *Luheria*, p. 363

Forewing not as above, or if so, then crown not flat 10

10. (9) Ocelli exactly on crown margin over one third the distance from eyes to median line. Crown flat, anterior margin carinate; lateral margins of pronotum long and carinate ..... *Cerrillus*, p. 362

Ocelli either near eyes, or crown and pronotum with margins not carinate, or both 11

11. (10) Forewing with only one closed anteapical cell or with none. Appendix always present 47

Forewing with two or more closed anteapical cells. Appendix present or absent 12

12. (11) Clypellus with lateral margins straight and parallel except basally; apex of clypellus extended beyond normal curve of lateral margins of genae (Pl. XXXIV, fig. 9A). Apex of head subconical 46

Clypellus usually constricted, with margins not parallel, or apex of clypellus not extended beyond normal curve of lateral margins of genae. Apex of head seldom subconical 13

13. (12) Lateral margins of genae not sinuated below eyes (Pl. XXXII, figs. 3A, 3B); genae visible behind eyes in dorsal view (Pl. XXXII, fig. 3). Crown produced and angled; reflexed veinlets to costal margin of forewing always present (Pl. XXIX, fig. 1) ..... *Scaphytopius*, p. 367

Lateral margins of genae usually sinuated below eyes; genae never visible behind eyes in dorsal view. Crown variable; reflexed veinlets to costal margin of forewing either present or absent 14

14. (13) Forewing with numerous ramose lines and false veins 28

Forewing without ramose lines and false veins 15

15. (14) Forewing with two or more reflexed veinlets to the costal margin in the vicinity of the outer anteapical cell 16

Forewing without reflexed veinlets to costal margin 21

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* This is probably media separating from cubitus. See remarks, page 365.

16. (15) Crown of nearly uniform length, broad, and with a distinct transverse furrow just behind anterior margin. Broad, somewhat flattened species, *Bahita*, p. 379
Crown much longer medially than next eyes, or, if short, lacking the transverse furrow 17
17. (16) Crown flat, anterior margin carinate..... *Hecaloidia*, p. 378
Crown not flat, or if so, anterior margin not carinate..... 18
18. (17) Crown only slightly longer medially than next the eyes ..... *Menosoma*, p. 379
Crown about twice as long medially as next the eyes..... 19
19. (18) Forewing with reflexed veinlets to costal margin much broadened; central anteapical cell very narrow distally (Pl. XXIX, fig. 3).... *Scaphoidula*, p. 368
Reflex veinlets to costal margin of forewing not broadened; central anteapical cell not extremely narrow distally..... 20
20. (19) Outer anteapical cell of forewing less than half as long as central anteapical cell (Pl. XXIX, fig. 7). Crown not distinctly angled (Pl. XXXII, fig. 7) ..... *Garapita*, p. 369
Outer anteapical cell of forewing over half as long as central anteapical cell and not so broad. Crown angled (Pl. XXXII, fig. 6)..... *Osbornellus*, p. 369
21. (15) Crown produced, ocelli very large and situated as near to apex of head as to eyes (Pl. XXXII, fig. 8). Antennae as long as body..... *Portanus*, p. 370
Crown either produced or not, but if produced, ocelli never as above. Antennae of various lengths..... 22
22. (21) Forewings not reaching beyond third abdominal segment..... *Faltala*, p. 385
Forewings reaching at least to ninth abdominal segment, usually extending beyond abdomen 23
23. (22) Forewing with only two closed anteapical cells..... 30
Forewing with three or more closed anteapical cells..... 24
24. (23) Crown extremely long and angled (Pl. XXXII, fig. 9), with a flat disk. Forewing narrowed apically from inner margin (Pl. XXIX, fig. 9)... *Agudus*, p. 371
Crown not as above. Forewing with appendix longer and not narrowed from inner margin 25
25. (24) Outer anteapical cell of forewing divided into 3–5 smaller cells. Apex of forewing subtruncate (Pl. XXIX, fig. 6)..... *Kanorba*, p. 374
Outer anteapical cell of forewing not divided. Apex of forewing rounded.. 26
26. (25) Head narrower than thorax (Pl. XXXIII, fig. 1); apex turned slightly upward ..... *Cumora*, p. 374
Head as wide or wider than thorax; apex seldom turned upward..... 27
27. (26) Broad, comparatively flat species. Pygofer with numerous, stout, closely set setae ..... *Sanctanus*, p. 371
Not distinctly broad or flat species. Pygofer with setae usually rather sparse ..... *Deltocephalus*, p. 373
28. (14) Ramose lines and false veins of forewing occurring only in area between radius and cubitus (Pl. XXIX, fig. 8)..... *Caphodus*, p. 375
Ramose lines and false veins of forewing not limited to area between radius and cubitus 29
29. (28) Head very short and broad; ocelli large, distant from eyes about three times their own diameter (Pl. XXXIII, figs. 5, 5A)..... *Baroma*, p. 377
Head not unusually broad; ocelli near eyes..... *Phlepsius*, p. 376
30. (23) Forewing without appendix, inner margin extended in a nearly straight line from tip of clavus to apex..... 31
Forewing with a distinct appendix, inner margin rounded from tip of clavus to apex 32
31. (30) Crown longer medially than next to eyes; head narrower than pronotum (Pl. XXXIV, fig. 5) ..... *Acinopterus*, p. 388
Crown very short and of uniform length; head as wide as pronotum (Pl. XXXI, fig. 4) ..... *Cariancha*, p. 360
32. (30) General form broad and flat; crown flat and short with anterior margin thin. Crown and pronotum transversely striated..... *Brincadorus*, p. 361
General form occasionally broad but not flat; crown with anterior margin not thin. Crown and pronotum not striated..... 33
33. (32) Forewing with only one claval vein, or with second claval vein very close to inner margin. Face very short, in profile swollen between antennae, *Onura*, p. 387
Forewing with two distinct claval veins. Face neither unusually short nor swollen between antennae 34
34. (33) Crown flat or nearly so, distinctly separated from the face by a subcarinate margin. Species slender 35
Crown not flat, or if so, very short and species robust. Crown not separated from face by a distinct margin..... 36

35. (34) Outer anteapical cell of forewing petiolate at least basally (Pl. XXVIII, fig. 8). Crown with two shallow, transverse furrows.....*Bolarga*, p. 366
Outer anteapical cell of forewing truncate basally (Pl. XXIX, fig. 4). Crown flat .....*Bonamus*, p. 365

36. (34) Crown over twice as long medially as next eyes (Pl. XXXIV, fig. 10). Ocelli small and distant from eyes.....*Benala*, p. 390
Crown not twice as long medially as next eyes. Ocelli either near eyes or unusually large 37

37. (36) Appendix extending around apex of forewing. Clypellus tapering distally (Pl. XXXIII, fig. 10A).....*Exitianus*, p. 382
Appendix not extending around apex of forewing. Clypellus not as above, 38

38. (37) Crown sloping abruptly downward anteriorly; clypeus much swollen in profile (Pl. XXXIV, fig. 1A). First and second apical cells of forewing unusually large (Pl. XXX, fig. 1) .....*Eusceloidia*, p. 384
Crown not sloping downward abruptly; clypeus not swollen as above. Apical cells of forewing of more uniform size..... 39

39. (38) Head distinctly wider than pronotum. Wedge-shaped leaf hoppers..... 40
Head about as wide as pronotum or slightly narrower. Not wedge-shaped leaf hoppers 41

40. (39) Outer anteapical cell of forewing narrowed at both ends. Clypellus short and nearly parallel margined.....*Opsius*, p. 381
Outer anteapical cell of forewing not narrowed distally. Clypellus extending beyond genae but with apex rounded and basal portion constricted, *Alaca*, p. 386

41. (39) Frontal sutures extending past ocelli onto crown.....*Hegira*, p. 383
Frontal sutures terminating at ocelli 42

42. (41) Pronotum unusually large and humped in profile (Pl. XXXIV, fig. 3). Clypellus extended beyond genae.....*Brazosa*, p. 386
Pronotum not unusually large and not humped in profile. Clypellus not distinctly extended beyond genae..... 43

43. (42) Crown comparatively flat and of nearly uniform length, never angular or subangular but always broadly rounded..... 44
Crown rounded downward, disk not flat; length of crown variable, frequently longer or shorter medially than next the eyes..... 45

44. (43) Outer anteapical cell of forewing broader distally than basally....*Bandara*, p. 380
Outer anteapical cell of forewing of nearly uniform width.....*Atanus*, p. 381

45. (43) Clypellus broad, scarcely or not at all constricted. Usually broad species, color green to brown.....*Chlorotettix*, p. 389
Clypellus narrow, usually distinctly constricted. Usually comparatively slender species, often with an angled vertex.....*Thamnotettix*, p. 388

46. (12) Forewing with three closed anteapical cells and no appendix...*Penestirellus*, p. 391
Forewing with two closed anteapical cells and usually a distinct appendix, *Stirellus*, p. 391

47. (11) Basal segment of hind tarsus with a distinct and deep groove in basal third ventrally. Slender, somewhat flattened species..... 50
Basal segment of hind tarsus without a distinct and deep groove basally. Species not flattened 48

48. (47) Forewing without closed anteapical cells.....*Cortona*, p. 390
Forewing with one closed anteapical cell..... 49

49. (48) Hind wing with four apical cells. Crown produced and angular or subangular .....*Baldulus*, p. 392
Hind wing with three apical cells. Crown not angular.....*Agelina*, p. 392

50. (47) Head wider than pronotum.....*Nesosteles*, p. 394
Head narrower than pronotum.....*Balclutha*, p. 393

51. (6) Sternal sclerites of mesothorax greatly enlarged, so that anterior coxa and trochanter reach only slightly beyond middle. Pronotum broadest near posterior margin. Appendix of forewing small or absent..... 55
Sternal sclerites of mesothorax not enlarged. Pronotum broadest just behind eyes. Appendix extending around apex of forewing..... 52

52. (51) Crown conical; median length over twice that next the eye.....*Conala*, p. 396
Crown not conical, but broad and short; median length not over one and one half times that next eye..... 53

53. (52) Forewing with less than three closed anteapical cells..... 54
Forewing with three closed anteapical cells (Pl. XXX, fig. 7)....*Idiotettix*, p. 395

54. (53) First cross vein of forewing absent (Pl. XXX, fig. 5). Basal portion of forewing coriaceous .....*Exolidia*, p. 395
First cross vein of forewing present. Wings hyaline.....*Neobala*, p. 396

55. (51) Hind wing with three apical cells. Crown distinctly produced anteriorly beyond eyes and distinctly longer medially than next eyes.....*Coelidiana*, p. 397
Hind wing with four apical cells. Crown produced anteriorly only slightly beyond eyes .....*Chinaia*, p. 397
56. (5) Anterior femora and tibiae broad and foliaceous.....*Gabrita*, p. 399
Anterior femora and tibiae neither broad nor foliaceous..... 57
57. (56) Tibiae of first two pairs of legs flattened.....*Terulia*, p. 399
Tibiae of first two pairs of legs not flattened.....*Jassus*, p. 398

DESCRIPTIONS OF JASSINE GENERA

Bythonia, new genus

(Pl. XXVIII, fig. 2; Pl. XXXI, fig. 1)

Intermediate in character between *Pachyopsis* Uhler and *Nionia* Ball, but differing from both in having the crown more distinctly separated from the face and in having the second apical cell of the hind wing very narrow. Easily separated from Nionia by the absence of circular punctures such as occur on the head, thorax, and forewings of the species of that genus.

Crown very short and broad, slightly shorter medially than next eyes. Face broad and short, ocellocular space with a distinct ledge above antennal socket. Pronotum broad, lateral margins distinctly carinate, surface transversely rugose. Forewing subcoriaceous, except extreme tip and appendix, which are membranous. Anteapical cells three in number; apical cells four; veins forming outer three apical cells practically parallel. Second cross vein joining media before base of the middle anteapical cell. Hind wing with second apical cell unusually narrow; costal cell distad of hamulus distinct and unusually large.

Type of the genus, *Nionia* (?) *rugosa* Osborn, 1923 (p. 32), a Bolivian species. No other species which could be referred to this genus are known to the writer.

Nionia Ball

(Pl. XXVIII, fig. 3; Pl. XXXI, fig. 2)

Nionia Ball, Proc. Biol. Soc. Wash., vol. 28, p. 165, 1915.

Correctly placed by Ball as a relative of *Tartessus* Stål, but even more closely related to *Thymbris* Kirkaldy and *Epipsychidion* Kirkaldy, with which it agrees in having an extremely short, broad, and curved crown, a strongly receding face, and no appendix on forewing. It differs from the above genera in being shorter and more robust and in having circular pits on the head, thorax, and at least the basal portion of the forewings. Not closely related to any American genus known to the writer.

Robust species, the known American forms all black in color, sometimes with apices of forewings reddish-brown. Head wider than thorax, eyes small, crown very short in its entire width, but usually slightly longer medially than at any other point. No distinct margin between crown and face. Ocelli distant from the eyes about four times their own diameter. Face rounded, clypellus unusually broad and tapering apically. Genae broad, lateral margins strongly sinuated. Ocellocular area produced into a distinct ledge over antennal socket. Pronotum long, but lateral margins very short and only weakly carinate. Scutellum small. Forewing coriaceous, circular pits arranged in rows along veins, anteapical cells three in number, the outer one often open distally. Hind wing with apical margin having a U-shaped excavation opposite the third and fourth apical cells, this excavation falling on the median line of the dorsum when the wing is folded in its normal position.

Type of the genus, *Goniagnathus palmeri* Van Duzee, 1891 (p. 171), a Nearctic species. The genus is known to be represented in South America by *Bythoscopus postica* Stål, 1860, and *Nionia major* Osborn, *N. gagatina* Osborn, with its variety *brunnea* Osborn, and *N. minor* Osborn, 1924. *Nionia* (?) *rugosa* Osborn, 1923, has been transferred to the genus *Bythonia*.

As pointed out by Kirkaldy, 1906 (p. 305 and 345), *Tartessus* Stål and its relatives are in many respects intermediate in character between typical Jassinae and typical Bythoscopinae. Nionia and Bythonia are the American representatives of this group, although Bythonia has less apparent affinities with Tartessus than has Nionia.

Xestocephalus Van Duzee

(Pl. XXVIII, figs. 4, 4A; Pl. XXXI, fig. 3)

Xestocephalus Van Duzee, Bull. Buffalo Soc. Nat. Sci., vol. 5, p. 214-215, 1894.

Related to *Acucephalus* Germar, with which it agrees in the position of the ocelli, the absence of an appendix on the forewing, and in having no submarginal vein at the apex of the hind wing. Differing from Acucephalus in that the head is narrower than the thorax and the outer anteapical cell of the forewing is small and much basad of its normal position. Kirkaldy placed Xestocephalus as a relative of *Phrynomorphus* Curtis, but the writer believes that it is properly placed near Acucephalus, as indicated in the original description by Van Duzee.

Crown produced and rounded to the front, median length distinctly greater than length next eyes. Eyes small. Ocelli distant

from eyes about one third or one half the distance from eyes to apex of head. Face strongly receding, sometimes clypellus and lori somewhat flattened. Lateral margins of genae sinuated. Lateral margins of pronotum short, slightly diverging posteriorly, and carinate. Forewing hyaline; outer anteapical cell slender, usually lying along basal one half of central anteapical cell, but sometimes extending slightly farther distad; first apical cell small. Female pygofer armed with numerous large setae, ovipositor curved downward posteriorly. Male plates and pygofer armed with either spinelike or feathery setae or both.

Type of the genus, *Xestocephalus pulicarius* Van Duzee, 1894, a Nearctic species. The genus appears to be almost cosmopolitan in distribution, typical representatives being present on all continents of the world except Europe. The entire genus must be carefully worked before the specific status of some of the South American forms can be determined. Members of the genus recorded from South America are: *Deltocephalus superbus* Provancher, 1890, *Xestocephalus pulicarius* Van Duzee and *X. tessellatus* Van Duzee, 1894, *X. brunneus* Van Duzee, 1907, and *X. irroratus* Osborn, 1924.

Cariancha, new genus

(Pl. XXXI, fig. 4)

Short, broad leaf hoppers resembling *Goniagnathus* Fieber in general form but not closely related to any genus known to the writer. Distinguished by the extremely short, broad head with the crown rounded to the front, and the forewings without appendices.

Crown very short, about five times as broad as long. Ocelli distant from the eyes about three times their own diameter. Face short and broad; clypellus unusually narrow; lateral margins of genae sinuated below eyes. Pronotum as broad as head, about four times as long as crown, surface faintly and irregularly transversely striated, lateral margins very short and feebly carinate. Forewing tapered to bluntly pointed apex, closed anteapical cells two in number and of approximately equal size. Pygofer with numerous short, stout setae.

Type of the genus, *Cariancha cariboba,* n. sp., from Brazil.

Cariancha cariboba, new species

General color, shining reddish-brown. Crown pale, with an indefinite transverse band of brown to fuscous above ocelli; base of pronotum and scutellum usually with similarly colored areas. Forewing subhyaline, with small whitish spots in cells near apex.

Length of female, 6 mm.; width of pronotum, 2.25 mm. Crown of nearly uniform length throughout its width. Forewing with two or three extra veins to costal margin opposite outer anteapical cell; apex of outer anteapical cell close to costal margin.

Last ventral segment of female with posterior lateral angles rounded, posterior margin with a median V-shaped notch.

Holotype female and two female paratypes labeled "Rio," P. R. Uhler collection. No other data. Types in the collection of the United States Museum, Cat. No. 51662.

Brincadorus, new genus

(Pl. XXXI, fig. 5)

Related to *Stroggylocephalus* Flor, which it resembles in general form and shape of the broad, short crown, but differing from that genus and from *Acucephalus* Germar in that the forewing has a distinct and membranous appendix and the hind wing has a distinct submarginal vein apically.

Crown broadly rounded anteriorly, anterior portion and thin anterior margin with numerous fine, transverse striae. Ocelli distant from eyes about two and one half times their own diameter. Face short and relatively flat, clypellus unusually short and broad, lateral margins of genae sinuated below eyes. Pronotum broad, surface of posterior portion with fine transverse striae. Forewing short and broad, closed anteapical cells two in number.

Type of the genus, *Brincadorus laticeps*, n. sp., from Brazil and Bolivia. So far as known, this is the only species belonging to this genus.

Brincadorus laticeps, new species

General ground color yellowish-white. Crown with an indefinite transverse band of reddish-brown; thorax, forewing, except tip, and dorsum of abdomen washed with the same color.

Length of male, 5.75–6 mm. A broad, flat species. Clypellus swollen, distinctly curved in profile. Posterior margin of pronotum shallowly and angularly excavated; scutellum large.

Male valve large, apex bluntly rounded or subtruncate. Plates extending upward and backward around the posterior ventral angle of the pygofer and tapering to sharp, spinelike apices which converge behind the pygofer. Aedeagus visible, extending downward and backward from near the apex of the valve.

Holotype male and 1 male paratype, Chapada, Brazil, January, C. F. Baker collection. Also 1 male paratype labeled Rurrenabaque,

Beni, Bolivia, W. M. Mann, December, 1921, Mulford Biological Exploration, 1921-'22. Types in the collection of the United States National Museum, Cat. No. 51663.

Cerrillus, new genus

(Pl. XXXI, fig. 6)

Related to *Hecalus* Stål by the flat crown with a thin margin, but differing from that genus in having the head, pronotum, and scutellum finely rugose rather than granulose and in having the ocelli about half way between the eyes and the apex of the head rather than next the eyes. No obvious sexual dimorphism.

Crown over twice as long medially as next the eyes, apex subangular. Lateral margins of genae sinuated. Pronotum short and broad, lateral margins carinate and slightly diverging posteriorly, posterior margin broadly, shallowly, and angularly excavated. Forewing short, but exceeding abdomen, appendix distinct, closed anteapical cells two in number.

Type of the genus, *Hecalus notatus* Osborn, 1923 (p. 27), known to occur in Brazil and Bolivia. This is the only species at present included in the genus.

Arrugada, new genus

(Pl. XXVIII, fig. 5; Pl. XXXI, fig. 7)

Apparently related to *Huleria* Ball by the venation and angulate head, but differing from that genus in the character of the head and anterior half of the pronotum, which are coarsely and irregularly rugose, and in having the numerous setae on the ventral surface of the basal segment of the hind tarsus not arranged in the normal two rows but distributed over most of the ventral surface.

Crown about twice as long medially as next the eyes, apex slightly turned upward; margin between crown and front distinctly carinate or subfoliaceous. Ocelli distant from the eyes about three times their own diameter. Lateral margins of genae incised below the eyes, below incision broadly rounded to apex of clypellus; genae comparatively broad next clypellus. Antennae mounted on a short tubercle which resembles a basal antennal segment. Pronotum large, lateral margins unusually long and distinctly carinate, disk and posterior half faintly, transversely rugose. Forewing subcoriaceous, long and comparatively slender, with a distinct appendix and normally with two closed anteapical and four apical cells. Venation of hind wing normal.

Type of the genus, *Huleria rugosa* Osborn, 1924 (p. 404), a Bolivian species. The genus will also include *Huleria affinis* Osborn, 1924, from the same region.

Luheria Osborn

(Pl. XXVIII, fig. 9; Pl. XXXI, fig. 8)

Luheria Osborn, Ann. Carn. Mus., vol. 15, no. 1, p. 31, 1923.

Resembling *Selenocephalus* Germar in the shape of the short, broad crown, but differing from that genus in having the outer anteapical cell of forewing roughly triangular and the central anteapical cell constricted near distal end. In the opinion of the writer this genus is not closely related to *Huleria* Ball, near which it was placed by Osborn, since *Huleria* has an elongate and subfoliaceous crown, the ocelli are distant from the eyes, and the anteapical cells of the forewing are slender and parallel-sided.

Crown but little longer medially than next the eyes, anterior margin broadly and evenly rounded, with a few faint transverse striae. Ocelli distant from eyes slightly more than twice their own diameter. Face broad, clypellus constricted near base, lateral margins of genae evenly curved except for a faint sinuation below each eye. Pronotum broad and nearly flat, lateral margins faintly carinate. Forewing broad, scarcely tapered distally, lacking a distinct appendix, claval veins connected by one or two cross veins, apical cells very short.

Type of the genus, *Luheria constricta* Osborn, 1923, described from Brazilian specimens and now known to occur also in northern Argentina. No other species belonging to the genus are known to the writer.

Egenus, new genus

(Pl. XXVIII, fig. 6; Pl. XXXI, fig. 10)

Most closely related to *Parabolocratus* Fieber, with which it agrees in having two elongate anteapical cells in the forewing, but differing from that genus in that the forewing is acuminate and the front is swollen. Differing from *Dorycephalus* Kuschakewitch, with which it agrees in the form of the forewing, in having the crown much shorter and the margin not foliaceous, and in the structure of the pronotum.

Crown produced and broadly rounded anteriorly, the anterior margin thin and turned upward, leaving a semicircular concave area anterior to the ocelli. Ocelli about one and one half times their

diameter from the eyes. Clypeus strongly convexly rounded between antennae when seen in profile. Pronotum short, lateral margins short and carinate, carina curved slightly upward posteriorly in lateral view. Forewing long, appendix absent, apical and anteapical cells slender. Ovipositor sheath not extending beyond the short pygofer.

Type of the genus, *Egenus acuminatus,* n. sp., from Argentina. This is the only species included in the genus at present.

Egenus acuminatus, new species

A large, pale-yellow species without definite markings but probably green in life, as are most species of *Parabolocratus.*

Length of female, 8.5 mm. Crown slightly wider than long, median length over twice that next the eye and equal to median length of pronotum. Pronotum broad, but slightly narrower than head, posterior portion with shallow transverse rugae. Costal margin of forewing but slightly curved; forewing tapered beyond clavus about equally from each margin.

Last ventral segment of female distinctly longer than preceding segment, posterior margin with a faintly incised median lobe, lateral angles rounded. Pygofer short, but extending slightly beyond ovipositor sheath.

Holotype female from Loreto, Prov. Missiones, Argentina, Dec. 14, 1931, A. A. Ogloblin. Type in collection of the United States National Museum, Cat. No. 51664.

Spangbergiella Signoret

(Pl. XXVIII, fig. 7; Pl. XXXII, figs. 1, 1A)

Spangbergiella Signoret, Ann. Ent. Soc. France, ser. 5, vol. 9, pp. 273-274, 1879.
Bergiella Baker, Can. Ent., vol., 29, pp. 157-158, 1897. (New synonymy.)

Elongate, somewhat flattened leaf hoppers; the crown distinctly produced medially and the margin always foliaceous in the females and frequently so in the males; the pronotum broad and short, with lateral margins long and distinctly carinate.

Crown extremely variable in length, always twice, usually several times as long medially as next eyes; margin of crown varying from foliaceous to bluntly rounded; disk of crown usually flat or slightly convex. Ocelli on narrow margin of crown, next to or near eyes. Pronotum with lateral margins nearly straight, either nearly parallel or slightly diverging posteriorly from eyes. Forewing long and rather slender, appendix very narrow, usually not distinctly mem-

branous; claval veins usually one, but occasionally two, in number; first cross vein rarely present and then very short; usually entirely absent and the media joining cubitus for a short distance; one anteapical cell present, the base of this pointed. Ovipositor sheath extending beyond pygofer.

Type of the genus, *Glossocratus vulneratus* Uhler, 1877 (p. 464), a North American species. The genus occurs only in America so far as known. South American species referred to the genus include *Spangbergiella lacerdae* Signoret, 1879, *Hecalus lynchii* Berg, 1879, *Spangbergiella punctato-guttata* Berg and *S. felix* Berg, 1884, and *Parabolocratus uruguayensis* Berg, 1884. The writer has been unable to examine either types or authentically determined specimens of *P. uruguayensis* Berg, upon which Baker based his genus Bergiella, but finds nothing in either Berg's or Baker's characterizations which would seem to justify separating Bergiella from Spangbergiella. The status of lynchii is in doubt, having been placed as a synonym of *vulnerata* Uhler by Signoret, 1880, Berg, 1884, and Ball, 1899; however, since Signoret's figures of *S. lacerdae*, August, 1879, from Bahia, Brazil, scarcely agree with *vulnerata* Uhler, it seems more probable that *lacerdae* Signoret is a distinct species and has as a synonym *lynchii* Berg, December, 1879.

Lawson, 1932 (p. 116), has characterized Spangbergiella as having ". . . inner branch of first sector (of forewing) forking well cephalad on disc of corium, radius three-branched resulting in five apical cells . . .," an interpretation of the venation which the writer believes unwarranted, since specimens are occasionally found in which the venation at the base is of the normal type except that the cross vein is extremely short. The writer's interpretation of the venation is given in the description of the genus.

Bonamus, new genus

(Pl. XXIX, fig. 4; Pl. XXXI, fig. 9)

Related to *Spangbergiella* Signoret, but with crown margin never foliaceous and forewing with a distinct appendix and two anteapical cells.

Crown nearly flat, distinctly longer medially than next the eyes, not angled anteriorly, anterior margin not thin or foliaceous. Face rather flat, lateral margins of genae strongly sinuated below eyes. Pronotum short, lateral margins short and only weakly carinate. Forewing long and slender, anteapical cells lying about parallel to claval suture, the outer cell shorter than the central one. Ovipositor

sheath long, extending beyond slender pygofer for about one third its total length. Genital segments of both sexes with numerous large setae.

Type of the genus, *Bonamus lineatus,* n. sp., from Argentina. A second species, from the same locality and apparently undescribed, will also be included in the genus.

Bonamus lineatus, new species

A pale blue-green to yellowish-white species with narrow dorsal, longitudinal lines of orange-red. Crown usually whitish, sometimes suffused with blue-green, with three parallel stripes, one next each eye and one in the middle, these continued across pronotum and scutellum. Pronotum with an additional pair of stripes, one behind each eye, these continued across middle of clavus of each forewing and meeting on commissural line. Forewing subhyaline, suffused with blue-green to yellowish-white, marked with orange-red along commissural line, across middle of clavus, along outer margin of claval suture, and in cells of corium basad of apical cross veins, these markings less distinct than the dorsal ones.

Length, 5–6 mm. Crown as long as basal width, median length over twice that next eye and equal to median length of pronotum. Pronotum slightly narrower than head, posterior margin broadly and shallowly excavated. General form, slender.

Male valve elongate and triangular, plates together somewhat spoon-shaped, ventral surfaces covered with long setae. Last ventral segment of female long, median portion broadly notched about half way to base of segment, with a blunt toothlike projection at base of notch. Pygofer and distal third of ovipositor sheath with numerous long setae.

Holotype male, allotype female, and 3 male and 10 female paratypes from Loreto, Prov. Missiones, Argentine, collected by A. A. Ogloblin in 1931, the holotype on December 6, the allotype on December 1, and the paratypes on various dates from November 27 to December 14. Types in collection of the United States National Museum, Cat. No. 51665.

Bolarga, new genus

(Pl. XXVIII, fig. 8; Pl. XXXII, fig. 2)

Resembling *Laevicephalus* De Long in general appearance, but apparently not closely related to the Deltocephalus group. Similar to *Osbornellus* Ball in the shape of the anteapical cells of the forewing, but lacking the reflexed veinlets to the costal margin.

Crown produced and subangular, disk with two broad, shallow, transverse furrows, one between the eyes and the other just in front of the ocelli. Margin between crown and face subcarinate. Ocelli near eyes. Face comparatively flat; genae broad and lateral margins broadly notched below the eyes. Pronotum short, lateral margins not carinate. Forewing with a distinct appendix, second cross vein absent, outer anteapical cell broader distally, central anteapical cell strongly constricted near apex, fourth apical cell unusually small, costal area with a cross vein to costal margin at each end of outer anteapical cell. Pygofer with numerous stout setae which are arranged in rather definite groups.

Type of the genus, *Parabolocratus bolivianus* Osborn, 1923 (p. 32), from Bolivia. An apparently undescribed species from nothern Argentina also belongs here. The writer considers *bolivianus* variety *pallida* Osborn, 1923, unworthy of varietal rank and places it as a synonym of bolivianus. (New synonymy.)

Bolarga is not closely related to Parabolocratus, where its type species was placed by Osborn, and is easily separated from that genus by the shape of the cells of the forewing.

Scaphytopius Ball

(Pl. XXIX, fig. 1; Pl. XXXII, figs. 3, 3A, 3B)

Scaphytopius Ball, Can. Ent., vol. 63, p. 218, 1931.

Easily separated from other genera of the Jassinae by the flat crown, broad genae which extend up behind the eyes and are visible from above, and the reflexed veinlets in the costal area.

Crown produced and angled, disk flat; margin between crown and face distinct, often carinate. Ocelli near eyes. Front very narrow and elongate, distinctly constricted just beyond base of clypellus. Genae broad, lateral margins not sinuated. Pronotum short, slightly wider than head; lateral margins short, diverging posteriorly and subcarinate. Forewing with a distinct appendix, numerous reflexed veinlets to the costal margin opposite outer anteapical and outer discal cells, and usually three, but sometimes only two, closed anteapical cells.

Type of the genus, *Platymetopius elegans* Van Duzee, 1890 (p. 94), a Nearctic species. The genus is known to occur only in the Nearctic and Neotropical regions. In addition to the species referred to Scaphytopius by Ball, 1932 (p. 252), the genus as above defined will include the species placed in *Deltopinus* Ball (type, *Platymetopius nigriviridis* Ball, 1909), *Cloanthus* Ball (type, *Platy-*

metopius angustatus Osborn, 1905), *Platymoideus* Ball (type, *Platymetopius trilineatus* Ball, 1916), *Nasutoideus* Ball (type, *Playtmetopius nasutus* Van Duzee, 1907), and *Convelinus* Ball (type, *Platymetopius nigricollis* Ball, 1916), those groups being here considered as subgenera of Scaphytopius. In making a phylogenetic arrangement of the species the writer has found these segregates very useful, but is of the opinion that the differences in markings and the sexual dimorphism exhibited by certain groups are an insufficient basis for the establishment of genera. These groups are separated in a key by Ball, 1931 (p. 217).

Species of Scaphytopius recorded from South America are: *Jassus* (*Deltocephalus*) *marginelineatus* Stål, 1858; *Jassus* (*Deltocephalus*) *anticus* Stål, 1860; *Platymetopius loricatus* Van Duzee, 1894; *Platymetopius fuliginosus* Osborn and *P. sulphureus* Osborn, 1923; and *Scaphytopius bolivianus* (new name for *Platymetopius lineolatus* Osborn, 1923, not *Platymetopius lineolatus* Motschulsky, 1859).

Scaphoidula Osborn

(Pl. XXIX, fig. 3; Pl. XXXII, fig. 4)

Scaphoidula Osborn, Ann. Carn. Mus., vol. 15, no. 1, p. 41, 1923.

Related to *Scaphoideus* Uhler by the shape of the outer anteapical cell of the forewing, but with the crown margin more rounded, the reflexed veinlets to costal margin of forewing much broadened and not situated anterior to base of outer anteapical cell, and with the large setae near the tip of the pygofer not arranged in groups as is typical of Scaphoideus.

Crown about twice as long medially as next the eye, apex bluntly angled, disk convex, margin between crown and face rounded. Head about as wide as pronotum. Ocelli comparatively large and situated next the eyes. Lateral margins of genae sinuately curved, genae very narrow next clypeus. Pronotum longer than vertex, lateral margins short and faintly carinate, posterior margin broadly and shallowly excavated between basal angles of scutellum. Forewing slender, with a distinct appendix and two closed anteapical cells, the outer about half as long as the second and not lying parallel to costal margin, the second narrowed apically. Antenna about half as long as forewing.

Type of the genus, *Scaphoidula cingulata* Osborn, 1923, a Neotropical species. Three closely related species from Central America and northern South America are also referred to this genus.

Osbornellus Ball

(Pl. XXXII, fig. 6)

Osbornellus Ball, Jl. Wash. Acad. Sci., vol. 22, no. 1, p. 17, 1932.

Closely related to *Scaphoidula* Osborn by the reflexed veinlets to the costal margin and the shorter outer anteapical cell of the forewing, but differing from that genus in that the outer anteapical cell of the forewing lies nearly parallel to the costal margin and the reflexed veinlets to the costal margin are not broadened.

Head and thorax as in Scaphoidula; head often slightly narrower than pronotum. Second anteapical cell of forewing not narrowed apically, costal area occasionally with a reflexed veinlet anterior to base of outer anteapical cell.

Type of the genus, *Scaphoideus auronitens* Provancher, 1889 (p. 277), a Nearctic species. South American species belonging to the genus are *Scaphoideus hyalinus* Osborn, *S. affinis* Osborn, *S. fulvomaculatus* Osborn, and *S. mexicanus* Osborn. Ball, 1932, placed *mexicanus* Osborn as a doubtful synonym of *Portanus stigmosus* (Uhler), but the cotype of mexicanus in the United States National Museum collection is an Osbornellus closely related to *consors* Uhler. A specimen identical specifically with this cotype was sent to Mr. J. N. Knull, curator of insects at Ohio State University, who kindly compared it with the three cotypes in the collection there and reported it to be the same. It appears, therefore, that mexicanus is properly placed in the genus Osbornellus.

Garapita, new genus

(Pl. XXIX, fig. 7; Pl. XXXII, fig. 7)

Related to *Scaphoidula* Osborn and *Osbornellus* Ball in having a shorter outer anteapical cell and reflexed veinlets in the costal area of the forewing, but differing from those genera in that the outer anteapical cell is even smaller, the crown is shorter and less angled, and the head is distinctly wider than the pronotum.

Crown relatively flat, margin between crown and face rounded, median length about twice that next the eyes. Ocelli near eyes. Clypellus unusually broad and convex; genae narrow, lateral margins sinuated below the eyes. Lateral margins of pronotum short, not distinctly carinate. Forewing long and slender, appendix distinct, closed anteapical cells two in number, the outer petiolate and distinctly less than half as long as the central cell, the latter not so

narrow distally as in Scaphoidula, reflexed veinlets to costal margin usually three in number and situated in vicinity of outer anteapical cell. Pygofer with numerous stout setae.

Type of the genus, *Garapita garbosa,* n. sp., from northern Argentina. A closely related species from the same locality also belongs here.

Garapita garbosa, new species

Body below yellow except for fuscous marks on abdomen; above black with longitudinal stripes of yellow. Crown marked with yellow as follows: Narrow anterior margin, three small spots on disk marking corners of a triangle with the apex anterior, and a dash near each ocellus, all these spots frequently minute or absent in the male, and a small, triangular basal area which is the beginning of a broad median stripe across pronotum and scutellum. Forewing black to fuscous except for narrow yellow marks along commissural line, claval veins, claval suture, and media, and the hyaline costal area and inner apical cell, the hyaline costal area being opposite the anteapical cells and interrupted by the black veinlets to costal margin.

Length, 4.25–5 mm. Crown bluntly angled in female, less produced in male. Pronotum longer than crown, posterior margin broadly and shallowly concave. Forewing broad apically, apical cells unusually large.

Male valve small and triangular, plates slender and elongate, tapering rather gradually to the somewhat acuminate tips. Last ventral segment of female much longer than preceding segment, posterior margin truncate or slightly produced medially, subcarinate medially on posterior third.

Holotype male, allotype female, and 4 male and 6 female paratypes from Loreto, Prov. Missiones, Argentina, collected in 1931 by A. A. Ogloblin. The holotype was taken on December 10, the allotype on December 14, and the paratypes on various dates from November 29 to December 18. Types in the collection of the United States National Museum, Cat. No. 51666.

Portanus Ball

(Pl. XXXII, fig. 8)

Portanus Ball, Jour. Wash. Acad. Sci., vol. 22, no. 1, p. 18, 1932.

Resembling *Osbornellus* Ball in general form, but differing in that the ocelli are larger and distant from the eyes, the antennae are longer, and the two anteapical cells of the forewing are of nearly equal size.

Crown about twice as long medially as next the eye, apex rounded, not angled as in Osbornellus. Margin between crown and face rounded. Ocelli unusually large, situated on anterior margin of crown at about midpoint between eyes and apex of head. Antenna as long as or longer than wings, basal segments large; antennal socket unusually deep. Forewing with two closed anteapical cells which are nearly parallel-sided and of about equal length, veinlets to costal margin not reflexed; a distinct appendix absent, and with the veins usually intermittently marked with white.

Type of the genus, *Scaphoideus stigmosus* Uhler, 1895 (p. 77), a West Indian species. South American species referable to the genus are *Scaphoideus boliviensis* Baker (*S. bicolor* Osborn, 1923, nec *S. bicolor* Ball, 1909), *S. hasemani* Baker (*S. punctulatus* Osborn, 1923, nec *S. punctulatus* Melichar, 1903), and *S. longicornis* Osborn.

Sanctanus Ball

(Pl. XXIX, fig. 2; Pl. XXXII, fig. 5)

Sanctanus Ball, Jour. Wash. Acad. Sci., vol. 22, no. 1, p. 10, 1932.

Related to *Amplicephalus* DeLong by the structure of the head, but differing from that genus in that the second cross vein of the forewing is always present, the second anteapical cell is always constricted and divided, and there is usually a slightly reflexed vein to the costal margin from near the base of the outer anteapical cell.

Crown relatively flat, anterior margin usually produced and angled medially, sometimes only slightly longer medially than next eyes, median length nearly equal to or less than median length of pronotum. Ocelli near eyes. Front relatively slender; lateral margins of genae sinuated below eyes. Lateral margins of pronotum very short. Forewing relatively large, frequently with extra short veins in clavus and anteapical cells; appendix distinct, reaching to apex of forewing. Pygofer with numerous large setae, sometimes arranged in rather indefinite groups, never in compact groups as in *Scaphoideus* Uhler.

Type of the genus, *Jassus sanctus* Say, 1831 (p. 307), a Nearctic species. Representatives of the genus known to occur in South America are *Scaphoideus fasciatus* Osborn, 1900, *Jassus* (*Deltocephalus*) *ornatipennis* Stål, 1858, and *Jassus* (*Deltocephalus*) *lepidellus* Stål, 1860.

Agudus, new genus

(Pl. XXIX, fig. 9; Pl. XXXII, fig. 9)

Resembling *Platymetopius* Burmeister (*sensus strictus*) in that the crown is long and angled, but more closely related to certain

species now referred to *Sanctanus* Ball in the characters of the venation. Differing from *Platymetopius* and *Sanctanus* in having the crown distinctly longer than pronotum and flat on the disk.

Crown produced and angled, anterior margin not carinate except near apex. Face convex, clypellus unusually broad, lateral margins very short. Forewing long and slender, tip curved away from abdomen, appendix small; inner margin of forewing tapering to apex more sharply than outer margin, closed anteapical cells normally three in number, the central one much larger than either the inner or the outer. Pygofer of both sexes armed with numerous long setae.

Type of the genus, *Agudus typicus,* n. sp., from Argentina. Four other species, represented by specimens from northern Argentina and Paraguay, also belong to this genus. One of these species is undoubtedly *Platymetopius longiceps* Berg, 1879, as the specimens fit his description exactly except that they are not "densissime punctulatus" and do not have the face "distincte punctato," but are finely granulose.

Agudus typicus, new species

General ground color pale yellowish-white. Crown washed with smoky-brown except for a narrow median line from apex to median suture, and irregular lines on crown margin anterior to ocelli; the pale lines margined with fuscous, especially at apex of crown and outer margins of parallel basal stripes. Face washed with brownish-fuscous except for a narrow and frequently interrupted median line, six or seven narrow transverse lines which do not reach median line, and a broad stripe just below crown margin. Pronotum with seven faint brown longitudinal stripes, deflexed lateral margins marked with contrasting fuscous-brown and yellow. Scutellum unevenly washed with yellowish-brown. Forewing with costal margin on basal half bright yellowish-white, remainder subhyaline; veins pale, faintly margined with fuscous; cells faintly embrowned, with four fuscous spots, one on clavus near claval suture, one at base of inner discal cell, one at base of central anteapical, and one along inner margin of inner anteapical cell.

Length of female, 5.25 mm. Ratio of median length of crown to median length of pronotum, 2½ to 1½; ratio of length of crown to shortest interocular space, 2½ to 1½. Lateral margins of crown nearly straight, curved slightly at apex.

Last ventral segment of female with a longitudinal median carina, posterior margin broadly, concavely excavated.

Holotype female and 2 female paratypes from Loreto, Prov. Missiones, Argentina, collected in 1931 by A. A. Ogloblin, the holotype on December 1, the paratypes on December 6. Types in the collection of the United States National Museum, Cat. No. 51667.

Deltocephalus Burmeister

Deltocephalus Burmeister, Genera Ins., vol. 1, pl. 14, 1838.

Small, frequently short leaf hoppers, grass-feeding so far as known. Forewing usually with three anteapical cells.

Crown produced and frequently angled, frequently flat and with a distinct margin anteriorly, but never separated from the face by a carina. Ocelli next eyes. Lateral margins of genae sinuated. Forewing either long or short.

Type of the genus, *Cicada pulicaria* Fallén, 1826 (p. 34), a Palearctic species now known to occur in the Nearctic region also. The genus as here defined is world wide in distribution and contains a great diversity of forms, many groups of which have been segregated as subgenera. The South American species are too numerous to review here.

The typical forms of the genus may be separated from the other two South American subgenera by the following key:

1. Crown distinctly angled. Species unusually long and slender.....*Haldorus*,
   Crown produced but not distinctly angled. Species not unusually slender.... 2
2. (1) Width of crown greatly exceeding median length. Large species...*Amplicephalus*,
   Width of crown about equal to median length. Smaller species...*Deltocephalus*,

Deltocephalus subgenus *Amplicephalus* De Long

Deltocephalus subgenus *Amplicephalus* De Long, Ohio State University Studies, vol. 2, p. 83, 1926.

The characters for the separation of this subgenus are indicated in the key.

Type of the subgenus, *Deltocephalus osborni* Van Duzee, 1892c (p. 304), a North American species.

Deltocephalus subgenus *Haldorus*, new subgenus

Differing from the typical *Deltocephalus* in being more elongate, slender, with a flat crown and pointed head. Forewing with central anteapical cell nearly always constricted and divided.

Type of the subgenus, *Thamnotettix venatus* Osborn, 1924, a South American species. The subgenus will also include about twenty-five closely related South American species, most of them apparently undescribed.

Cumora, new genus

(Pl. XXXIII, fig. 1)

Related to the *Deltocephalus* group, with which it agrees in venation, but differs in having the crown more angular and turned upward apically.

Crown about twice as long medially as next the eyes, anterior margin not carinate, but crown distinctly separated from face. Ocelli next eyes. Face relatively flat, lateral margins of genae broadly sinuated. Head slightly narrower than pronotum. Pronotum short, lateral margins not carinate. Forewing long and slender, appendix distinct, central anteapical cell constricted and divided.

Type of the genus, *Cumora angulata,* n. sp., from northern Argentina. A second species from the same locality is also referred to this genus.

Cumora angulata, new species

Face fuscous with numerous pale areas. Ground color of dorsal regions tawny. Anterior margin of crown with four small fuscous spots, pronotum with four longitudinal reddish stripes, and veins of forewing milky-white.

Length, 5 mm. Clavus with veins usually connected.

Male valve comparatively large; plates small and tapered to blunt tips. Last ventral segment of female short, with a single median tooth on posterior margin.

Holotype male, allotype female, and 4 female paratypes from Loreto, Prov. Missiones, Argentina, collected in 1931 by A. A. Ogloblin, the holotype on December 10, the allotype on November 27, and the paratypes on various dates from December 1 to December 18. Types in the collection of the United States National Museum, Cat. No. 51668.

Kanorba, new genus

(Pl. XXIX, fig. 6; Pl. XXXIII, fig. 2)

Resembling *Scaphoideus* Uhler in general appearance, but with disk of crown concavely excavated, outer anteapical cell of forewing divided into several small cells, and with reflexed veinlets to costal margin opposite outer discal cell of forewing.

Crown produced and angled, margin between crown and face distinct but not carinate. Ocelli near the eyes. Face broad and comparatively flat; clypellus broad distally, constricted just beyond base; genae broad, lateral margins slightly sinuated. Pronotum short, lateral margins not carinate. Forewing broad, subtruncate

apically, appendix distinct, claval veins connected by a cross vein, second cross vein present, costal area with two reflexed veinlets to costal margin opposite outer anteapical cell and three or four opposite the outer discal cell. Pygofer with numerous stout setae.

Type of the genus, *Kanorba reflexa*, n. sp. No other species are referred to the genus.

Kanorba reflexa, new species

General ground color creamy-white. Face washed with pale brown. Crown with an irregular brown area on the disk with extensions to the anterior margin next the ocelli and median line. Pronotum with four broad, indefinite, longitudinal brown stripes; scutellum with brown areas basally. Forewing subhyaline brown with numerous hyaline areas; tip and reflexed veinlets to costal margin fuscous.

Length, 5–5.25 mm. Crown with apex slightly turned upward, other structures as given for the genus.

Male valve short and triangular. Plates together broad basally and tapered to pointed tips, the two plates not touching at any point along median line. Last ventral segment of female with a faint median notch on truncate posterior margin.

Holotype male, allotype female, and 1 female paratype from Corumba, Brazil, C. F. Baker collection, the holotype and allotype labeled "March" and the paratype "May." Types in the collection of the United States National Museum, Cat. No. 51669.

Caphodus, new genus

(Pl. XXIX, fig. 8; Pl. XXXIII, fig. 4)

Resembling *Osbornellus* Ball in general habitus, and related to that genus in the structure of the head, but allied to *Phlepsius* Fieber by the presence of ramose lines and false veins in the forewings. Differing from *Osbornellus* by the presence of the false veins and from *Phlepsius* by the shape of the anteapical cells.

Crown produced and angled as in *Scaphoidula* Osborn, the margin between the crown and face distinct but not angled. Ocelli near eyes. Face and pronotum as in *Scaphoidula*. Forewing with a distinct appendix, outer anteapical cell broader distally and with a reflexed veinlet to costal margin from each end, central anteapical cell narrowed medially. Second cross vein usually absent, ramose lines and false veins restricted to area between radius and cubitus. Pygofer with numerous large setae.

Type of the genus, *Caphodus maculatus*, n. sp. The genus will also contain *Scaphoideus obliquus* Osborn, 1923, from Brazil.

Caphodus maculatus, new species

Closely related to *obliquus* Osborn, differing in being slightly smaller, having a less flattened crown, shorter and more tapered male plates, and with the posterior margin of the last ventral segment of the female excavated instead of produced.

General ground color yellowish-white. Crown with four small fuscous spots on anterior margin and a pair of large orange-red spots on the disk. Face fuscous, interrupted on clypeus with numerous short, transverse, pale marks. Pronotum with a pair of orange-red spots basally and four faint orange spots on disk, the latter somewhat elongate and resembling traces of longitudinal vittae. Scutellum with indefinite orange marks basally. Forewing with a distinct fuscous spot on clavus next claval suture, smoky brown coloration on most of clavus except three opalescent dashes next commissural line, a fuscous spot on corium between media and cubitus anterior to base of central anteapical cell, and another fuscous area at apex of central anteapical cell following outer apical vein to wing margin. Veins and false veins mostly brown to fuscous, the two reflexed veinlets to costal margin black.

Length, 5.25–5.75 mm. Structurally this species is identical with obliquus except for the proportionally smaller size.

Male valve broad basally, triangular in shape. Plates broad basally, but tapering gradually to pointed tips, margins with a row of large setae and above these a row of fine hairlike setae. Last ventral segment of female long, with a median carina which ends in a blunt median tooth on posterior margin; posterior margin broadly excavated and with a caudal projection at each side which curves slightly toward the median line.

Holotype male, allotype female, and 10 male and 2 female paratypes from Loreto, Prov. Missiones, Argentina, collected in 1931 by A. A. Ogloblin, the type on December 18, the allotype on December 8, and the paratypes on various dates from November 25 to December 18. Types in the collection of the United States National Museum, Cat. No. 51670.

Phlepsius Fieber

Phlepsius Fieber, Verh. Zoöl.-Bot. Ges. Wien, vol. 16, p. 503, 1866.

Relatively large, frequently robust species, with numerous ramose lines and false veins in the forewings. Color usually some shade of brown or near brown.

Crown of varying lengths and shapes, either margined or rounded to the front. Face usually broad, lateral margins of genae sinuated. Lateral margins of pronotum not at all or only feebly carinate. Forewing broad, appendix distinct, closed anteapical cells either two or three in number. Costal area frequently with reflexed veinlets to costal margin in South American species.

Type of the genus, *Jassus intricatus* Herrich-Schaeffer, 1838, a Palearctic species. South American species referred to the genus include *Phlepsius lacerdae* Signoret, 1879; *Phlepsius gracilis* Osborn, *hasemani* Osborn, *saranensis* Osborn, *sparsus* Osborn, *loricatus* Osborn, *annulatus* Osborn, *clypeatus* Osborn, and *signatus* Osborn, 1923; and *Eutettix punctatus* Osborn, 1923.

The genus as here defined contains a great diversity of forms, and careful study of all of the species of the group is needed to decide the status of the following segregates which have been established in the North American fauna and are at present considered as subgenera: *Paraphlepsius* Baker, type *Paraphlepsius ramosus* Baker, 1897; *Iowanus* Ball, type *Phlepsius* (*Iowanus*) *handlirschi* Ball, 1918; *Texananus* Ball, type *Phlepsius* (*Texananus*) *mexicanus* Ball, 1918; *Dixianus* Ball, type *Phlepsius utahnus* Ball, 1909; *Zionius* Ball, type *Phlepsius extremus* Ball, 1901; and *Pendarus* Ball, type *Phlepsius slossoni* Ball, 1905.

Baroma, new genus

(Pl. XXXIII, figs. 5, 5A)

Resembling *Idiotettix* Osborn in the shape of the short, broad head and elongate form, but differing from that genus in having no ledge above the antennal socket, and in the small size of the appendix of the forewing. More closely related to *Phlepsius* Fieber, with which it agrees in having numerous ramose lines and incomplete cross veins in the forewing, but differing from Phlepsius by the extremely short, broad head. Differing from *Remadosus* Osborn and Ball in the shape of the facial sclerites and in the structure of the forewing.

Head broader than pronotum; crown about seven times as broad as long, broadly curved anteriorly, of uniform length and rounded to the face. Ocelli large, distant from the eyes about three times their own diameter. Face nearly flat, front strongly constricted at base of clypellus; genae broad, lateral margins broadly rounded from below eyes. Pronotum broad and rather short, disk faintly, transversely striated, lateral margins short and faintly carinate. Scutellum unusually large. Forewing long, venation irregular, but with three closed anteapical cells and several extra cross veins to costal

margin; appendix distinct, but not extending around apex of wing as in Idiotettix. Pygofer short and broad, without large setae.

Type of the genus, *Baroma reticulata,* n. sp., from northern Argentina. This is the only species belonging to the genus known to the writer.

Baroma reticulata, new species

General ground color pale yellowish-white, often with a bluish-green tint. Anterior and middle pairs of legs, front, and entire dorsal surface mottled with brown, deepened to fuscous on apex of forewing; head less heavily marked with brown.

Length, 7.75 mm.; width of head, 2.3 mm. Pronotum evenly convex, without depressed areas. Inner apical cell rather large, remaining cells slender.

Male valve broad and triangular, plates elongate, tapering to pointed tips, pygofer very broad and flattened dorsoventrally, easily visible beyond plates laterally. Last ventral segment of female with posterior margin concavely excavated from lateral angles and with a narrow median V-shaped notch.

Holotype male, allotype female, and 1 male paratype from Loreto, Prov. Missiones, Argentina, collected by A. A. Ogloblin in 1931, the holotype on December 18, the allotype and paratype on December 12. Types in collection of the United States Museum, Cat. No. 51671.

Hecaloidia Osborn

(Pl. XXIX, fig. 10; Pl. XXXIII, fig. 3)

Hecaloidia Osborn, Ann. Carn. Mus., vol. 15, no. 1, p. 28, 1923.

Resembling certain species of the genus *Phlepsius* Fieber, but differing from that genus in lacking ramose lines in the forewings. Related to *Mesamia* Ball by the reflexed costal veinlets. Apparently not closely related to either *Hecalus* Ball or *Huleria* Ball, near which it was placed by Osborn, since reflexed veinlets in the costal area of the forewings do not occur in those genera.

Crown flat or slightly concave; anterior margin thin, but not foliaceous, with faint transverse striae. Length of crown on median line, about twice that next eye; apex subangular. Ocelli situated next the eyes. Face broad and flat, nearly straight in profile; lateral margins of genae strongly sinuated below eyes, genae very narrow next clypellus. Pronotum slightly longer than crown, lateral margins short and faintly carinate. Forewing elongate, with

distinct appendix, two closed anteapical cells and a few reflexed veinlets in costal area, some of these anterior to the base of the short outer anteapical cell.

Type of the genus, *Hecaloidia nervosa* Osborn, a Bolivian species. No other species belonging to this genus are known to the writer.

Menosoma Ball

(Pl. XXXIII, fig. 6)

Menosoma Ball, Florida Ent., vol. 15, p. 4-5, 1931.

Resembling *Eutettix* Van Duzee in general habitus. Differing from that genus in having the crown more produced medially and rounded to the face, the transverse furrow in the crown absent or very faint, and usually a few reflexed veinlets to the costal margin of the forewing near the outer apical cell. Menosoma also lacks the distinct striae which occur on the crown and pronotum of typical species of Eutettix.

Crown short, but usually distinctly longer medially than next eyes. Ocelli large, situated near eyes. Front narrow, strongly constricted at base of clypellus. Genae broad, lateral margins sinuated below eyes. Forewing with a distinct appendix; closed anteapical cells usually two in number, the outer sometimes divided.

Type of the genus, *Menosoma stonei* Ball, 1931, known only from the southern part of the United States. The following members of the genus occur in South America: *Eutettix cinctus* Osborn and Ball, 1898; *Mesamia fasciata* Osborn, 1923; and *Eutettix neocinctus* Osborn, and *E. elegans* Osborn, 1923.

Bahita, new genus

(Pl. XXIX, fig. 5; Pl. XXXIII, fig. 8)

Intermediate in character between *Eutettix* Van Duzee and *Menosoma* Ball; differing from the former in lacking the distinct striae on the crown and pronotum and in having reflexed veinlets to the costal margin of the forewing; distinct from Menosoma by having a much shorter head and distinct transverse furrow on the crown, which is distinctly margined anteriorly.

Crown short and of nearly uniform length, sometimes slightly longer medially than next the eye; anterior margin carinate or subcarinate. Crown with a distinct transverse furrow across entire width anterior to disk. Ocelli near eyes. Frontal sutures usually

extending past ocelli onto vertex and terminating at transverse furrow. Face convex; front broader than in Eutettix or Menosoma; genae broad, with lateral margins sinuated. Pronotum short, lateral margins not carinate. Forewing with a distinct appendix; closed anteapical cells two in number, the outer short and lying obliquely with respect to costal margin; the central narrowed medially; costal area with two or three reflexed veinlets to costal margin near base of outer anteapical cell. Pygofer with a few stout setae.

Type of the genus, *Eutettix infuscatus* Osborn, 1923 (p. 52), from Brazil and Bolivia. The genus, which appears to be limited in distribution to Central and South America, is well represented in that region. The following described species are referred here: *Jassus (Athysanus) palliditarsus* Stål, 1860; *Eutettix irroratus* Osborn, *E. femoratus* Osborn, and *E. laticeps* Osborn, 1923; and *Aligia plena* Van Duzee, 1933, from Costa Rica.

Bandara Ball

Bandara Ball, Bull. Brooklyn Ent. Soc., vol. 26, p. 93, 1931.

Closely related to *Eutettix* Van Duzee, but without the distinct striae on the crown and pronotum which are characteristic of that genus. Differing also in having the outer anteapical cell of the forewing distinctly shorter than in Eutettix and broader distally than basally.

Crown about as in Eutettix, but transverse furrow usually not distinct. Ocelli distant from the eyes about one and one half times their own diameter. Face short and broad as in Eutettix. Lateral margins of pronotum short and faintly carinate. Forewing with a distinct appendix; closed anteapical cells two in number, the second more narrowed medially than is true of Eutettix; outer apical cell unusually large and usually somewhat semicircular in shape. Setae of pygofer short. Color tawny or yellow, usually with opalescent spots on forewing.

Type of the genus, *Eutettix johnsoni* Van Duzee, 1894 (p. 137), a Nearctic species. The only South American representative of the genus known to the writer is *Mesamia hyalina* Osborn, 1923, described from Colombia. Specimens at hand from Trinidad, Grenada, and the Dominican Republic are considered to be this species. Osborn's description of hyalina as having "Abdominal segments of

female above punctate at spiracles" apparently refers to the dark depressions near the lateral margins of each segment on the dorsum, as all Cicadellidae examined by the writer have had the spiracles ventral in position.

Atanus, new genus

(Pl. XXXIII, fig. 7)

Closely related to *Opsius* Fieber, with which it agrees in general habitus, but differing in having the head of nearly the same width as the pronotum, the crown more nearly flat, the front more elongate and narrow, and the margins of the outer anteapical cell of the forewing nearly parallel.

Crown rather flat, not rounded to the face anteriorly, but lacking a distinct margin, median length distinctly greater than the length next the eyes. Face triangular, front narrow, genae joining clypellus only as a very narrow sclerite. Lateral margins of pronotum not carinate. Forewing with a distinct appendix, closed anteapical cells two in number, the outer shorter and more slender than the inner and with sides nearly parallel. Pygofer with numerous stout setae.

Type of the genus, *Eutettix dentatus* Osborn, 1923 (p. 57), described from Bolivia and also occurring in northern Argentina. The genus will also include *Eutettix tesselatus* Osborn, 1923; *Thamnotettix lobatus* Osborn, 1923; and twenty-five or more species closely related to dentatus. These are for the most part apparently undescribed, although several of the species described by Berg, 1881, 1884, as Athysanus probably belong here.

Opsius Fieber

Opsius Fieber, Verh. Zoöl.-Bot. Ges. Wien, vol. 16, p. 505, 1866.

Comparatively small, rather wedge-shaped leaf hoppers with a short, broad head and two anteapical cells in the forewing. Genae joining the clypellus as comparatively broad sclerites.

Crown slightly longer medially than next the eye, rounded downward to the front. Ocelli large, distant from the eyes about two and one half times their own diameter. Face broad and short; lateral margins of genae strongly sinuated below eyes; clypellus with sides approximately parallel. Lateral margins of pronotum very short. Forewing opaque except apically and along costal margin; a distinct appendix present; outer anteapical cell narrowed at both ends. Setae on pygofer short and stout.

Type of the genus, *Opsius stactogalus* Fieber, 1866, a species now cosmopolitan in distribution but thought to have come originally from the Mediterranean region.

Exitianus Ball

(Pl. XXXIII, figs. 10, 10A)

Exitianus Ball, Trans. Amer. Ent. Soc., vol. 55, p. 5, 1929.

Mimodrylix Zachvatkin, Moscow Univ., Sci. Proc., No. 4, p. 108, 1935. (Type, *Thamnotettix capicola* Stal, 1855, an African species). (New synonymy.)

Most closely related to *Nephotettix* Matsumura, with which it agrees in the shape of the clypellus and in having the appendix extended around the apex of the forewing. Differing from Nephotettix in lacking the transverse furrow on the crown, in having the crown rounded to the face rather than margined anteriorly, and in having the outer anteapical cell comparatively large, normally truncate at both ends, and extending to the fourth apical cell, rather than very small, acuminate posteriorly, and not extending to the base of the fourth apical cell. Exitianus differs from *Athysanus* Burmeister and *Euscelis* Brullé, where the species have frequently been placed, by the shape of the clypellus and the appendix of the forewing.

Crown longer medially than next the eyes, disk convex and anterior margin rounded to the face. Ocelli large, distant from the eyes about their own diameter. Clypellus unusually long, narrowed gradually from base to apex. Lateral margins of genae sinuated below eyes. Forewing hyaline, appendix unusually large, closed anteapical cells two in number. Pygofer and distal portion of ovipositor sheath of female with a few stout setae. Plates of male with a row of large setae along lateral margins, posterior margins of pygofer with two or three unusually stout setae. Ovipositor sheath extending beyond pygofer.

Type of the genus, *Cicadula exitiosa* Uhler, 1880 (p. 72), which is at present considered to be a synonym of *Jassus* (*Thamnotettix*) *obscurinervis* Stål, 1859 (p. 293), described from Brazil. Other American species belonging to the genus are the following: *Athysanus picatus* Gibson, 1919, and its synonym *A. miniaturatus* Gibson, 1919; *Euscelis quadratula* Osborn, 1923; *Euscelis pallida* Osborn, 1926; and *Athysanus digressus* Van Duzee, 1933. *Exitianus armus* Ball, 1923, does not belong to the genus as here restricted, and may be referred to the already crowded *Thamnotettix* Zetterstedt until it can be disposed of more satisfactorily. African, European, and Asiatic species belonging to *Exitianus* are as follows: *Thamnotettix*

capicola Stål, 1855; *Athysanus fusconervosus* Motschulsky, 1863; *Jassus* (*Thamnotettix*) *taeniaticeps* Kirschbaum, 1868, *Athysanus indicus* Distant, *A. nanus* Distant, and *A. atkinsoni* Distant, 1908; *Athysanus transversalis* Matsumura, 1908; *Athysanus simillimus* Matsumura, 1914; and probably several others described as *Athysanus, Euscelis,* or *Phrynomorphus. Phrynomorphus* Curtis, 1833, type *nitidus* Curtis, 1833, is a synonym of *Euscelis* Brullé. The specific synonymy of all the species of Exitianus listed above is much involved and a study of much more material than is now available is needed to decide some of the points in question.

It would be difficult to find a more homogeneous group of species than those listed above, and there can be no doubt about the affinities of the American, European, Asiatic, and African species.

Hegira, new genus

(Pl. XXXIII, fig. 9)

Related to *Ophiola* Edwards and *Euscelis* Brullé, but differing from both in having the face longer and the frontal sutures extending beyond the ocelli onto the anterior margin of the crown. Distinct from Ophiola in having the head narrower than the thorax and from Euscelis in having a larger appendix on the forewing.

Crown short, but longer medially than next the eyes, rounded to the face. Ocelli near eyes. Front long, strongly constricted near base of clypellus. Genae broad, lateral margins sinuated. Lateral margins of pronotum faintly carinate. Forewing broad, appendix large, closed anteapical cells two in number, the outer shorter than the central one. Costal area with a vein to costal margin from each end of the outer anteapical cell. Pygofer with numerous large setae. Male plates with many long, slender, silky-appearing setae on outer margins.

Type of the genus, *Hegira brunnea,* n. sp., from northern Argentina. A specimen of the same or a closely related species is at hand from Brazil.

Hegira brunnea, new species

Face brown with numerous pale-yellowish areas, the most constant being transverse marks on the clypeus. Crown yellowish-white with a pair of transverse brown dashes between the eyes, a pair of small spots at the apex, and a pair of larger spots on the posterior margin. Pronotum washed with brown, with numerous irregular pale areas on the anterior submargin. Scutellum brown

with two yellowish-white spots on each lateral margin. Forewing subhyaline, marked with brown on veins and in cells, the intracellular marks restricted to the distal area.

Length, 6-6.5 mm. Structure as indicated for the genus.

Male valve broad and short, triangular in shape. Plates together bluntly spoon-shaped, basal width about equal to length.

Last ventral segment of female large, median portion slightly longer than lateral portion, with a small median notch on posterior margin.

Holotype male, allotype female, and 9 male and 7 female paratypes from Loreto, Prov. Missiones, Argentina, collected in 1931 by A. A. Ogloblin, the holotype on December 14, the allotype on December 6, and the paratypes on various dates from November 27 to December 18. Types in the collection of the United States National Museum, Cat. No. 51672.

Eusceloidia Osborn

(Pl. XXX, fig. 1; Pl. XXXIV, figs. 1, 1A)

Eusceloidia Osborn, Ann. Carn. Mus., vol. 15, no. 1, p. 46, 1923.

Superficially resembling macropterous specimens of the fulgorid genus *Bruchomorpha* Newman; apparently related to *Exitianus* Ball by the wing venation, but easily distinguished from that genus by the very large apical cells of the forewing and the greatly swollen clypeus.

Crown short and sloping downward anteriorly, broadly rounded to the face. Ocelli distant from eyes about one and one half times their own diameter. Clypeus greatly swollen, especially next clypellus.

Lateral margins of genae sinuated, genae very narrow next clypellus. Pronotum short, lateral margins very short and not carinate. Forewing rather broad, appendix and first and second apical cells unusually large. Closed anteapical cells two in number, the outer about half as long as the inner and lying along distal portion of that cell. The hind wings of the single specimen upon which the original description of the genus was based are badly torn, but the venation appears to be normal for the group, with four apical cells.

Type of the genus, *Eusceloidia nitida* Osborn, a Bolivian species, and, so far as known, the only representative.

Faltala, new genus

(Pl. XXXIV, fig. 2)

Broad, flat, and relatively short leaf hoppers, brachypterous so far as known. Resembling *Athysanella* Baker in general habitus, but probably not closely related to that genus.

Crown flat and broad, separated from the face by a distinct margin which is subcarinate at least apically. Median length of crown about twice as long as length next the eyes. Ocelli small, distant from the eyes two or three times their own diameter. Face broad and short, front unusually broad, genae with lateral margins incised below eyes. Pronotum shorter than crown, lateral margins comparatively long and subcarinate. Macropterous forms, if they occur, may be expected to have the lateral margins of the pronotum shorter. Forewing quadrangular in shape, truncate apically, not reaching to posterior margin of third abdominal segment, venation reticulated. Abdomen broad and much flattened, much broader than thorax. Pygofer with few or no setae.

Type of the genus, *Faltala brachyptera*, n. sp., from northern Argentina. No other species are included in the genus.

Faltala brachyptera, new species

General ground color pale yellowish-brown, with irregular ivory-colored markings on crown, pronotum, forewing, and abdomen, these markings, except those of forewing, margined with fuscous. Markings of crown illustrated in drawing (Pl. XXXIV, fig. 2), those of abdomen consisting of two oblique dashes near each lateral margin on segments 3 to 7, inclusive, and 3 broader dashes on each segment between the lateral dashes, all these arranged so as to form longitudinal stripes. Eighth abdominal segment with a fuscous spot near each lateral margin dorsally. Median portion of posterior margin of female genital segment black.

Length of male, 3 mm.; of female, 3.75 mm.; greatest width about 1.5 mm. Crown subangular apically. Posterior margin of pronotum broadly and shallowly incised. Scutellum broad and short.

Male valve broad and short. Plates short and broad, extending only a short distance beyond apex of valve. Pygofer terminating in short points posteriorly. Last ventral segment of female with median portion of posterior margin slightly produced and tridentate.

Holotype male, allotype female, and 3 female paratypes from Loreto, Prov. Missiones, Argentina, collected in 1931 by A. A. Ogloblin, the holotype on November 29, the allotype on November 25, 1 paratype on November 27, and the other 2 on November 29. Types in the collection of the United States National Museum, Cat. No. 51673.

Brazosa, new genus

(Pl. XXXIV, fig. 3)

Related to the Thamnotettix group, which it resembles in general habitus, but differing in having the pronotum much larger and humped in profile, and in the shape of the crown.

Crown short and broad, median portion sometimes slightly produced. Crown not separated from face by a distinct margin. Face broad, clypellus extended beyond genae, lateral margins of genae sinuated. Pronotum large, lateral margins carinate. Forewing hyaline, closed anteapical cells two in number.

Type of the genus, *Thamnotettix picturellus* Baker, 1923 (p. 532), (*Thamnotettix pictus* Osborn 1923, from Brazil, not *Thamnotettix pictus* Lethierry, 1875). The genus will also contain *Thamnotettix amazonensis* Osborn, 1923, from Brazil.

Alaca, new genus

(Pl. XXXIV, fig. 4)

Related to the *Thamnotettix* group, with which it agrees in general habitus and wing venation, but differing in having the head broader than the pronotum and the crown short and of uniform length.

Crown short and rounded downward to the face. Face convex, clypellus strongly constricted. Pronotum short, lateral margins weakly carinate. Forewing comparatively slender, closed anteapical cells two in number, appendix distinct.

Type of the genus, *Alaca longicauda*, n. sp., from northern Argentina. The genus will also include *Agallia multipunctata* Osborn, 1923, and an apparently undescribed species from Bolivia.

Alaca longicauda, new species

General color sordid brown with a round black spot above each ocellus, a smaller fuscous spot on the pronotum behind each eye, and fuscous marks on the base of the scutellum.

Length of male, 5.5–6 mm. Forewing subhyaline.

Male valve very small, plates rather delicate and thin, strongly diverging distally and triangular in outline. Pygofer very long, about three times as long as plates, rounded apically in profile.

Holotype male and 28 male paratypes from Loreto, Prov. Misiones, Argentina, collected in 1931 by A. A. Ogloblin, the holotype on December 18 and the paratypes on various dates from November 25 to December 18. Types in the collection of the United States National Museum, Cat. No. 52091.

Onura, new genus

(Pl. XXXIV, fig. 7)

Related to *Thamnotettix* Zetterstedt in general structure and agreeing with that genus in the venation of the corium of the forewing. Distinct from Thamnotettix and related genera in that the face is strongly receding and short, the apex of the clypellus does not extend caudad of the posterior margin of the eyes, and the forewing has only one distinct claval vein.

Disk of crown shallowly concave, margin of crown broadly rounded to the face; face in profile most swollen between the antennae, constricted at the base of the clypellus. Ocelli large and situated near eyes. Clypellus short and nearly parallel sided; lateral margins of genae sinuated. Pronotum short, lateral margins not carinate. Forewing long, appendix distinct, costal margin coriaceous on basal two thirds, anteapical cells lying parallel to costal margin, the outer shorter and more slender than the central one. There is occasionally a trace of the second claval vein at the inner basal angle of the clavus. Claval vein usually with a cross vein to claval suture. Pygofer sparsely clothed with rather short setae.

Type of the genus, *Onura eburneola*, n. sp., from northern Argentina. Two other species, one from northern Argentina and the other from Brazil, will fall in this genus.

Onura eburneola, new species

Crown, anterior half of pronotum, and costal margin of forewing ivory colored. Ocelli orange. Upper portion of face, deflexed margins of pronotum, and sides of abdomen also ivory, below dirty yellow to fuscous. Crown and pronotum with faint, irregular yellow markings; posterior half of pronotum and all of scutellum dirty white. Forewing grayish-subhyaline, appearing slate-colored owing to the darker wings and dorsum of abdomen, with a fuscous stripe along radius parallel to costal margin and extending to apex of outer anteapical cell.

Length of female, 4.75 mm. Crown produced and bluntly angled, median length equal to length of pronotum and nearly twice the length of the crown next the eyes.

Last ventral segment of female subtruncate posteriorly, with a narrow, median, V-shaped notch which extends nearly to the base of the segment.

Holotype female and 1 female paratype from Loreto, Prov. Misiones, Argentina, collected in 1931 by A. A. Ogloblin, the holotype on December 18 and the paratype on December 14. Type in the collection of the United States National Museum, Cat. No. 51674.

Thamnotettix Zetterstedt

Thamnotettix Zetterstedt, Ins. Lapp., column 292, 1838.

Cicadula Zetterstedt, Ins. Lapp., column 296, 1838 (type, *Cicada quadrinotata* Fabricius, 1794, a palearctic species).

Thamnus Fieber, Verh. Zoöl.-Bot. Ges. Wien, vol. 16, p. 505, 1866 (type, *Thamnotettix confinis* Zetterstedt, 1838, a palearctic species).

Relatively elongate, slender species, without a distinct margin between the crown and the face of the head and with only two anteapical cells in the forewing.

Crown usually short, median length slightly longer than that next eyes. Head narrower or as wide as pronotum. Face relatively flat, lateral margins of genae sinuated. Ocelli situated near eyes. Lateral margin of pronotum short, not or only feebly carinate. Forewing relatively broad, second cross vein absent, appendix distinct.

Type of the genus, *Cicada prasina* Fallén, 1826, a Palearctic species. The genus as here defined continues to be the catch-all that it has been in the past. While many of the South American species described under this genus have been transferred to other genera, the number remaining is still too large to list here. As here defined the genus is cosmopolitan in distribution.

The genus Cicadula, as fixed by its type quadrinotata, is here considered as a synonym of Thamnotettix, while for the species of the genus Cicadula of authors the name *Macrosteles* Fieber (type, *Cicada sexnotata* Fallén, 1806) is available. Macrosteles apparently does not occur in South America.

Acinopterus Van Duzee

(Pl. XXX, fig. 2; Pl. XXXIV, fig. 5)

Acinopterus Van Duzee, Psyche, vol. 6, p. 308, 1892.

Related to *Thamnotettix* Zetterstedt by the structure of the short, bluntly angled crown, but differing from that genus in that the forewing lacks a distinct appendix and the inner margin is continued in a nearly straight line from the apex of the clavus to the bluntly pointed apex of the forewing.

Head narrower than pronotum; crown short and rounded to the front, longer medially than next the eyes. Ocelli situated near eyes. Face relatively flat; lateral margins of genae sinuated below eyes. Pronotum short and broad, lateral margins carinate and diverging posteriorly, pronotum broadest near posterior margin. Forewing with two, or occasionally three, closed anteapical cells, often with extra cross veins, particularly in clavus and along costal area opposite outer anteapical cell. Second apical cell of hind wing unusually narrow.

Type of the genus, *Acinopterus acuminatus* Van Duzee, 1892b (p. 308), an American species. So far as known, this is the only species of the genus which occurs in South America, and it appears to be limited to the extreme northern portion of the continent. Specimens from Colombia have been examined by the writer.

Chlorotettix Van Duzee

(Pl. XXVII, figs. 1, 1A, 1B, 1C, 1D; Pl. XXXIV, fig. 8)

Chlorotettix Van Duzee, Psyche, vol. 6, p. 306, 1892.

Closely related to *Thamnotettix* Zetterstedt by the venation and general form; differing from that genus in having the crown more rounded and of nearly uniform length throughout its width, and in that the forewings are never opaque.

Crown short and rounded to the front, median length equal to or slightly greater than that next to the eyes. Ocelli situated near eyes. Front comparatively slender; lateral margins of genae not strongly sinuated below eyes. Lateral margins of pronotum short and weakly carinate. Forewing long, without extra cross veins; closed anteapical cells two in number; appendix distinct. Pygofer with numerous stout setae.

Type of the genus, *Bythoscopus unicolor* Fitch, 1851 (p. 58), a Nearctic species. The genus appears to be restricted in distribution to the Americas and is represented in South America by *Chlorotettix breviceps* Baker and *Ch. minimus* Baker, 1898; *Ch. bakeri* Sanders and De Long, 1922; *Ch. neotropicus* Jensen-Haarup, 1922; *Ch. aberrans* Osborn, *Ch. delicatus* Osborn, *Ch. dilutus* Osborn, and *Ch. truncatus* Osborn, 1923; and *Thamnotettix luteosus* Baker. In addition to the above, there are at hand representatives of nineteen apparently undescribed species belonging to the genus.

Benala, new genus

(Pl. XXXIV, fig. 10)

Superficially resembling *Deltocephalus* Burmeister in size and general habitus, but different from that genus in having only two anteapical cells in the forewing and in that the ocelli are distant from the eyes.

Crown over twice as long medially as next the eyes, not distinctly separated from the face, but with the apex pointed. Ocelli over one third distance from eyes to apex of head. Face strongly receding, lateral margin of genae strongly sinuate. Pronotum shorter than head. Forewing with appendix distinct and inner apical cells unusually large.

Type of the genus, *Deltocephalus tumidus* Osborn, 1923, from Bolivia. No other species are referred to the genus.

Cortona, new genus

(Pl. XXX, fig. 6; Pl. XXXIV, fig. 6)

Related to *Lonatura* Osborn and Ball, which it resembles in size and general habitus. Differing from that genus in having a longer, more angled head and no closed anteapical cells in the forewing.

Head large in proportion to body, distinctly wider than pronotum. Crown produced and angled, rounded to face, length greater than length of pronotum. Ocelli situated near eyes. Clypellus unusually broad, tapering apically. Lateral margins of genae sinuated below eyes. Pronotum short, lateral margins very short. Forewing hyaline, appendix distinct, closed anteapical cells absent. Pygofer with numerous large setae.

Type of the genus, *Cortona minuta*, n. sp., from northern Argentina. This is the only species referred to the genus.

Cortona minuta, new species

Color, uniform golden yellow, wings hyaline.

Length of male, 2.3 mm.; length of head, pronotum, and scutellum, 0.9 mm.; width of head, 0.75 mm. Crown longer than pronotum, disk rather flat, median length twice that next the eyes. Forewing extending beyond tip of abdomen.

Male valve broad and short. Plates together subtriangular, tapering to pointed tips.

Holotype male from Loreto, Prov. Missiones, Argentina, December 3, 1931, A. A. Ogloblin. Type in the collection of the United States National Museum, Cat. No. 51675.

Stirellus Osborn and Ball

(Pl. XXXIV, figs. 9, 9A)

Athysanus subgenus *Stirellus* Osborn and Ball, Ohio Nat., vol. 2, p. 250, 1902.

Related to *Aconura* Lethierry,* with which it agrees in the shape of the head, in having a long clypellus, a small appendix and two closed anteapical cells in the forewing, and a long ovipositor sheath. Differing from Aconura in being shorter and more robust, with a shorter and less pointed head and broader, shorter anteapical cells in the forewing. *Anemochrea* Kirkaldy, *Anemolus* Kirkaldy, *Phrynophyes* Kirkaldy, *Nandidrug* Distant, and *Paivanana* Distant are all related to Stirellus and Aconura.

Small leaf hoppers. Crown produced and bluntly angled, rounded to the front, disk somewhat flattened. Head often subconical. Clypellus nearly parallel sided, extending beyond normal curve of genae, apex truncate. Lateral margins of genae sinuated. Pronotum shorter than crown, lateral margins very short and not carinate. Forewing comparatively broad, not reaching to tip of ovipositor sheath, appendix small. Ovipositor sheath extending well beyond apex of pygofer; pygofer of female usually with a few short, stout setae.

Type of the genus, *Athysanus bicolor* Van Duzee, 1892a (p. 114), an American species. In addition to *bicolor* the genus is known to be represented in South America by *Athysanus* (*Stirellus*) *mexicanus* Osborn and Ball, 1902, and two other species from northern Argentina.

Penestirellus Beamer and Tuthill

Penestirellus Beamer and Tuthill, Jour. Kans. Ent. Soc., vol. 7, pp. 21-22, 1934.

Related to *Stirellus* Osborn and Ball by the subconical head and long clypellus, but differing in having three closed anteapical cells in the forewing instead of two and in lacking an appendix. Differing from *Deltocephalus* Burmeister and related genera by the shape of the crown and facial sclerites.

Crown and face together subconical, disk of crown relatively flat, margin rounded to the face. Ocelli small and situated next the eyes. Front long, clypellus with sides nearly parallel and apex truncate or excavated and extended well beyond normal curvature of margins of genae. Lateral margins of genae strongly sinuated below

* The writer has not examined *Aconura jakolevi* Lethierry, 1876, the type of the genus. The generic concept is based on a study of several Japanese species.

eyes. Pronotum and scutellum unusually short. Hind wing slender, with anal area much reduced in size. Ovipositor sheath extended beyond pygofer.

Type of the genus, *Penestirellus catalinus* Beamer and Tuthill, 1934, known only from southern Arizona. The genus is represented in South America by an apparently undescribed species from northern Argentina.

Baldulus Oman

Baldulus Oman, Proc. Ent. Soc. Wash., vol 36, p. 79, 1934.

Related to *Macrosteles* Fieber (*Cicadula* of authors), with which it agrees in wing venation, but differing from that genus in being elongate and slender with a produced and angled crown. Resembling *Balclutha* Kirkaldy and *Nesosteles* Kirkaldy in the shape and venation of the forewing, but with four apical cells in the hind wing.

Crown produced and bluntly angled, rounded to the face without a distinct margin anteriorly. Ocelli small, distant from the eyes about one and one half times their own diameter. Face elongate, lateral margins of genae distinctly sinuated. Lateral margins of pronotum faintly carinate. Forewing with a distinct appendix, anteapical venation, as here interpreted, with outer cell absent and inner cell open basally, resulting in only one closed anteapical cell. The present interpretation of the venation of the hind wing results in four apical cells instead of three.

Type of the genus, *Baldulus montanus* Oman, 1934, known to occur only in southern Arizona. In addition to the two species originally referred to the genus, it will also include *Cicadula maidis* De Long and Wolcott, 1923, the only representative of the genus that is known to occur in South America. The writer has examined specimens of maidis from Puerto Rico, the type locality; Cuba; Coahuila, Mexico; Temple, California; and Tucuman, Argentina. The Argentine specimens were recorded "on sugar beet" and the California material was reported to be damaging young sweet corn.

Agelina, new genus

Related to *Macrosteles* Fieber (*Cicadula* of authors), with which it agrees in the venation of forewing and in general habitus, but differing from that genus in having only three apical cells in the hind wing. In the character of the venation of the hind wings the genus shows affinities to *Balclutha* Kirkaldy and *Nesosteles* Kirkaldy, but differs from these genera in several important structural details.

Crown produced and rounded, distinctly longer medially than next the eye. Ocelli distant from the eyes about one and one half times their own diameter. Face relatively broad. Lateral margins of pronotum short and not carinate. Forewing relatively broad and with a distinct appendix and one closed anteapical cell. Hind wing with three apical cells.

Type of the genus, *Agelina punctata,* n. sp., from Brazil and Argentina. No other species is referred to the genus.

Agelina punctata, new species

General ground color sordid yellowish-green; forewings smoky. Head marked with fuscous to black as follows: Face with short, broken, transverse arcs and a curved transverse band between and below the ocelli; crown with a transverse bar behind ocelli, this broken on median line and with lateral extremities curved downward between ocelli and eyes, and a round spot on each side of median line behind transverse bar. Base of pronotum often with irregular dark marks. Veins of forewings pale. Coloration extremely variable, transverse bar on crown sometimes obsolete and other markings indistinct.

Length of female, 3.25-3.75 mm. Structural details as indicated for the genus.

Posterior margin of last ventral segment of female subtruncate, very slightly sinuated and with a faint median notch.

Holotype female and 2 female paratypes from Loreto, Prov. Missiones, Argentina, December 18, 1931, collected by A. A. Ogloblin. Type in the collection of the United States National Museum, Cat. No. 51676.

Balclutha Kirkaldy

(Pl. XXX, figs. 4, 4A; Pl. XXXV, fig. 1)

Gnathodus Fieber (nec Pander, 1856), Verh. Zoöl.-Bot. Ges. Wien, vol. 16, p. 505, 1866 (type, *Cicada punctata* Thunberg, 1782).

Balclutha Kirkaldy, Entomologist, vol. 33, p. 243, 1900 (new name for *Gnathodus* Fieber).

Eugnathodus Baker, Invert. Pacifica, vol. 1, p. 1, 1903 (type, *Gnathodus abdominalis* Van Duzee, 1892, which is at present considered to be congeneric with *punctata* Thunberg.

Slender, relatively small leaf hoppers, with a short head which is narrower than the thorax. Forewing long and slender, with a large appendix and only one closed anteapical cell.

Crown slightly longer medially than next eyes, median length about one third median length of pronotum. Lateral margins of pronotum short but diverging posteriorly, pronotum widest some distance behind eyes. Wing with three apical cells, the reduction

caused by fusion of inner fork of radius and outer fork of media in apical region. Basal segment of hind tarsus with a distinct groove-like excavation on inner ventral surface at base.

Type of the genus, *Cicada punctata* Thunberg, 1782 (pl. 21), a Holarctic species. An apparently undescribed species from Bolivia is the only South American form referred to this genus.

Nesosteles Kirkaldy

(Pl. XXXV, fig. 2)

Nesosteles Kirkaldy, Hawaiian Sugar Planter's Assoc. Expt. Sta. Div. Ent. Bull. 1, p. 343, 1906.

Anomiana Distant, Fauna British India, Rhynchota, vol. 8, p. 109, 1918 (type, *Anomiana longula* Distant, 1918). (New Synonymy.)

Agellus De Long and Davidson, Ohio Jour. Sci., vol. 33, p. 210, 1933 (type, [*Eugnathodus*] *Agellus neglecta* De Long and Davidson, 1933).

Closely related to *Balclutha* Kirkaldy, differing in having the head broader, the crown shorter and usually not distinctly produced medially, the pronotum not distinctly wider than the head and with its lateral margins not diverging posteriorly, and the forewing usually not so long. Other characters as in Balclutha.

Type of the genus, *Nesosteles hebe* Kirkaldy, 1906, described from the Viti Isles. The genus, and many of the species included therein, is practically cosmopolitan in distribution, at least in the warmer regions of the world. This group is very closely related structurally to *Balclutha*, but is here retained as a distinct genus on the basis of the doubtfully distinct structural characters mentioned above and the apparent difference in distribution, *Balclutha* occurring primarily in Holarctic or Alpine regions while Nesosteles is the common form in warmer regions. The following species of the genus are recorded from South America: *Eugnathodus lineatus* Osborn, 1924, *E. flavescens* Baker, 1903, and *E. lacteus* Baker, 1903; the last two originally described from Central America and recorded from South America by Osborn in 1924. However, *E. lacteus* Baker is a synonym of *Gnathodus incisus* Matsumura, 1902, which will also have as synonyms *Eugnathodus bisinuatus* De Long, 1923, *Eugnathodus pallidus* Osborn, 1926, *Eugnathodus bifurcatus* De Long and Davidson, 1933, *Nesosteles areolata* Obsorn, 1934, and *Nesosteles tutuilana* Osborn, 1934. (New synonymy.) The last three names are included on the authority of Davidson and De Long, 1935 (p. 106-107), who suppressed them as synonyms of bisinuataus. *Balclutha hyalina* Osborn, 1926, which was also listed by Davidson and De Long as a synonym of bisinuatus, is here removed from synonymy. *Nesosteles incisa*

Matsumura was described from Japan and is known to occur in the Philippines and Hawaiian Islands in addition to the localities represented in the above synonymy. Identification of *N. incisa* is from Japanese specimens determined by Matsumura. *N. guajanae* De Long, 1923, is also known to occur in South America and the Philippine Islands.

Idiotettix Osborn

(Pl. XXX, fig. 7; Pl. XXXV, figs. 3, 3A)

Idiotettix Osborn, Ann. Ent. Soc. Amer., vol. 22, No. 3, p. 465, 1929.

Closely related to *Exolidia* Osborn by the shape of the head, the presence of ledges over the antennal sockets, and the shape of the appendix of the forewing, but differing from that genus in having three closed anteapical cells and a basal cross vein in the forewing.

Crown short and broad and of nearly uniform length, sloping downward anteriorly and rounded to the face, median suture at base absent or very short. Ocelli distant from eyes about twice their own diameter. Pronotum broadest just behind eyes, posterior margin roundly excavated medially. Scutellum large. Forewing large, appendix extended around the apex. Outer anteapical cell somewhat triangular in shape, base angled, central and inner anteapical cells truncate basally.

Type of the genus, *Thamnotettix magnificus* Osborn, 1924 (p. 424), from Bolivia. The genus also includes *Idiotettix bolivianus* Osborn, *I. fasciatus* Osborn, and *I. brunneus* Osborn, 1929, and a few apparently undescribed species as well.

Exolidia Osborn

(Pl. XXX, fig. 5; Pl. XXXV, fig. 4)

Exolidia Osborn, Ann. Carn. Mus., vol. 15, No. 1, p. 75, 1923.

General form robust, ledges above antennal pits distinct; forewing without a cross vein between R + M and Cu, and with apex obliquely subtruncate.

Head short and broad; crown broad, sloping downward to the much swollen clypellus, median basal suture absent. Ocelli distant from the eyes about twice their own diameter. Pronotum broadest next posterior margins of eyes, posterior margin concavely excavated. Forewing broad apically, appendix unusually broad opposite apex of inner apical cell, cubitus not forked, R + M forked but once, outer apical veins curved, first apical cell very small. Apical cells three, or possibly four, in number.

Type of the genus, *Exolidia picta* Osborn, a Brazilian species. No other species known to the writer at present can be referred to the genus as above defined.

Neobala, new genus

(Pl. XXX, fig. 3)

Related to *Exolidia* Osborn by the short, rounded crown, but separated from that genus by the venation of the forewing, which has a basal cross vein between R + M and Cu, and an anteapical cell which is truncate basally.

Crown of nearly uniform length, sloping downward anteriorly and rounded to face, disk with numerous fine, longitudinal striae, basal median suture absent or very short. Ocelli distant from eyes about twice their own diameter. Face convex, clypeus somewhat swollen, genae rather broad next clypellus. Pronotum as in *Exolidia*. Forewing slender and tapered apically, apex rounded, appendix large, apical veins not strongly curved as in *Exolidia*.

Type of the genus, *Thamnotettix pallidus* Osborn, 1923 (p. 67), from South America. The genus, which appears to be limited in distribution to tropical South America, will also include *Euscelis quadrimaculata* Osborn, 1923, and *Thamnotettix guaporensis* (new name for *Thamnotettix sordidus* Osborn, 1923, nec *Thamnotettix sordidus* Zetterstedt, 1838).

Conala, new genus

(Pl. XXXV, fig. 5)

Most closely related to *Neobala*, n. g., with which it agrees in wing venation; related to *Idiotettix* Osborn and *Exolidia* Osborn as well as to Neobala by the shape of the pronotum, which is broadest just behind the eyes. The genus differs from the above groups in the much produced and nearly conical head and the fine transverse pronotal striae, and bears a superficial resemblance to *Spangbergiella* Signoret because of the red dorsal markings of the head and thorax, but has no close structural affinities with that genus.

Crown greatly produced, apex narrowly rounded, disk slightly convex and with numerous fine, longitudinal striae, margins rounded to the face, and median basal suture absent. Ocelli small, distant from eyes about four times their own diameter. Face convex, ledge above antennal socket sometimes small. Pronotum with numerous fine, transverse striae, posterior margin angularly incised between

basal angles of scutellum. Forewing with a large appendix, one closed anteapical cell, the base of which is truncate, and two claval veins.

Type of the genus, *Spangbergiella fasciata* Osborn, 1923 (p. 29), from Brazil. This is the only species known at present which belongs to the genus.

Coelidiana, new genus

(Pl. XXX, fig. 8; Pl. XXXV, fig. 6)

Related to, and previously included in *Neocoelidia* Gillette and Baker, but differing from that genus, as determined by its genotype *tumidifrons* Gillette and Baker, 1895, in being much more elongate with wings extending well beyond the tip of the abdomen, and in having a carina separating the crown and face. Differing from *Chinaia* Brunner and Metcalf by the presence of the carina between the crown and face and in having only three apical cells in the hind wing.

Crown flat or nearly so, usually somewhat pentagonal in shape, distinctly raised above the eyes and separated from them by a short perpendicular wall, median length always greater than that next the eyes. Face strongly convex; clypellus comparatively slender. Pronotum wider than head, rather short; posterior margin broadly and shallowly incised; lateral margins comparatively long, distinctly carinate, somewhat curved and diverging posteriorly. Scutellum large. Forewing long and slender, with one closed, elongate, triangular anteapical cell. Appendix of forewing either very small or entirely absent.

Type of the genus, *Neocoelidia rubrolineata* Baker, 1898 (p. 290), from Brazil. Other South American species included in this genus are *Neocoelidia bimaculata* Baker and *N. modesta* Baker, 1898, and *N. inflata* Osborn and *N. croceata* Osborn, 1923. *Neocoelidia smithii* Baker, 1898, and probably *N. punctata* Osborn, 1923, and *N. ornata* Osborn, 1924, should be referred to the genus *Chinaia* Bruner and Metcalf.

Chinaia Bruner and Metcalf

(Pl. XXXV, figs. 7, 7A)

Chinaia Bruner and Metcalf, Bull. Brooklyn Ent. Soc., vol. 29, No. 3, pp. 120-121, 1934.

Most closely related to *Neocoelidia* Gillette and Baker and *Jassus* Fabricius by the broad genae, narrow head, long antennae, broad, short pronotum, and the reduced venation of the forewing.

Differing from Neocoelidia in having four apical cells in the hind wing and from Jassus by the venation of the forewing and the narrow costal area of the hind wing.

Crown raised above eyes and separated from them by a short, perpendicular area, rounded downward anteriorly to the front. Crown extending but slightly anterior to the eyes. Ocelli small, distant from the eyes about one third the distance from eyes to median line of vertex. Clypellus strongly constricted near base. Antennae extremely long, usually longer than entire body, basal segments large. Pronotum short, lateral margins diverging posteriorly and feebly carinate, posterior margin broadly and shallowly incised. Forewing long and slender, basal two thirds opaque, appendix small or absent, one closed anteapical cell present.

Type of the genus, *Chinaia bella* Bruner and Metcalf, 1934. The genus is represented in South America by *Neocoelidia smithii* Baker, 1898. *N. punctata* Osborn, 1923, and *N. ornata* Osborn, 1924, probably belong here also.

Chinaia was originally described as a member of the Bythoscopidae because of the position of the ocelli. However, as indicated earlier in this paper, that character, used alone, is unreliable as a criterion for separation of the higher groups. The structure of the head and thorax, as pointed out above, identify Chinaia as a relative of Jassus and related genera. The nymphal stages also bear a close resemblance to the very distinctive nymphs of Jassus.

Jassus Fabricius

(Pl. XXX, figs. 9, 9A; Pl. XXXV, figs. 8, 8A)

Jassus Fabricius, Syst. Rhyng., p. 85, 1803.

Coelidia Germar, Mag. d. Ent., vol. 4, pp. 38, 75, 1821. (Type, *Coelidia venosa* Germar, 1821, from Brazil.)

Comparatively large, robust leaf hoppers with simple venation of forewing, narrow crown, and long face.

Head narrower than thorax, crown unusually narrow, usually about as wide as one eye. Crown comparatively short, disk raised above level of eyes and separated from them by a short perpendicular area. Ocelli large, situated on crown margin about as near to the median line as to the eye. Crown usually rounded to the front, occasionally separated by a distinct margin. Face unusually long, clypeus of about equal width throughout, clypellus usually broadened distally, apex extending beyond genae. Genae reaching clypellus as broad sclerites, lateral margins sinuated. Pronotum

short, lateral margins diverging posteriorly and distinctly carinate; carinae about even with costal margins of forewings. Scutellum large. Forewing broad, usually broader apically than medially or basally, appendix distinct, with only one closed anteapical cell which is petiolate basally and truncate distally. Apical cells usually almost parallel margined.

Type of the genus, *Jassus nervosus* Fabricius, 1803, an American species. *J. nervosus* is not known to the writer but the generic description here presented is based on numerous American species believed to be congeneric with nervosus. Coelidia Germar appears to pertain to the longer headed American forms and may be found to be worthy of subgeneric or generic rank when the species are more fully known.

A large number of species from South America have been described in this genus, and since most of them appear to have been correctly placed generically they are not listed below.

Terulia Stål

Terulia Stal, Bidrag till Rio Janeiro-Traktens Hemipter-fauna, Pt. II. K. Svensk. Vet. Akad. Handl., vol. 3, p. 50, 1860.

Similar to Jassus Fabricius but larger and with the anterior and middle tibiae flattened but not broadened. Otherwise as in Jassus.

Type of the genus, *Terulia ferruginea* Stål, 1860, a Brazilian species. The writer has not seen examples of ferruginea, and the above description is based on a specimen which appears to belong to the genus.

Gabrita Walker

Gabrita Walker, List. Homop., Suppl., p. 254, 1858.

Petalopoda Spangberg, Ofv. Vet. Akad. Forh., vol. 36, p. 18, 1879. (Type, *Petalopoda annulipes* Spangberg, 1879, from South America.)

Closely related to *Jassus* Fabricius in all important structural characters except that the fore femora and tibiae are broad and foliaceous.

Type of the genus, *Gabrita annulivena* Walker, 1858, from South America. Neither *annulivena* nor *annulipes* are known to the writer from authentically determined material, but the characterization is based on a single specimen which appears to be *Petalopoda annulipes* Spangberg. *Petalopoda* is placed as a synonym of *Gabrita* on the basis of the descriptions of the two.

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PLATE XXVII

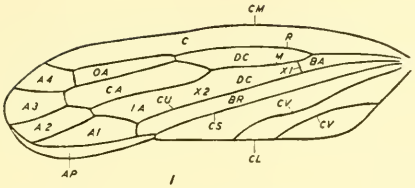
FIG. 1, forewing (× 7); 1A, hind wing (× 7); 1B, face (× 15); 1C, head and thorax (× 15); and 1D, left intermediate tibia and tarsus (× 30), of *Chlorotettix unicolor* (Fitch).

FIG. 2, forewing; and 2A, hind wing, of *Bythoscopus lanio* (Linnaeus) (× 7).

FIG. 3, forewing of *Pachyopsis laetus* Uhler (× 7).

FIG. 4, hindwing of *Oncopsis distinctus* (Van Duzee) (× 15).

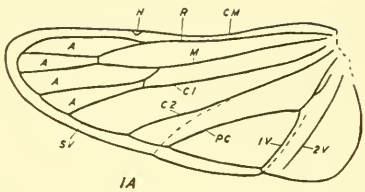
PLATE XXVII



1

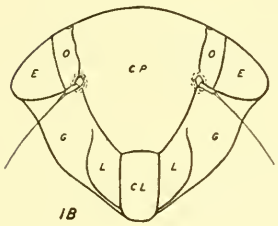
CM-COSTAL MARGIN
R -RADIUS
M -MEDIA
CU-CUBITUS
CS-CLAVAL SUTURE
CV-CLAVAL VEINS
CL-COMMISSURAL LINE
C -COSTAL AREA
BA-BASAL CELL
DC-DISCAL CELLS
BR-BRACHIAL CELL

OA-OUTER ANTEAPICAL
CA-CENTRAL ANTEAPICAL
1A-INNER ANTEAPICAL
X1-FIRST CROSS-VEIN
X2-SECOND CROSS-VEIN POSITION
A1-FIRST APICAL CELL
A2-SECOND APICAL CELL
A3-THIRD APICAL CELL
A4-FOURTH APICAL CELL
AP-APPENDIX



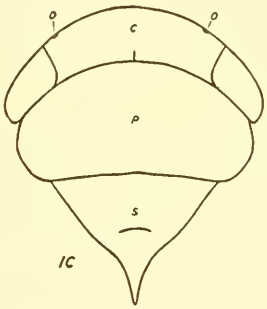
1A

CM-COSTAL MARGIN
R -RADIUS
M -MEDIA
C1-CUBITUS 1
C2-CUBITUS 2
PC-POSTCUBITUS
1V-FIRST VANNAL
2V-SECOND VANNAL
SV-SUBMARGINAL VEIN
N -NAMULUS
A -APICAL CELLS



1B

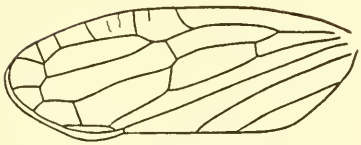
CP-CLYPEUS
CL-CLYPELLUS
O -OCELLOCULAR AREA
E -COMPOUND EYES
G -GENAE
L -LORI



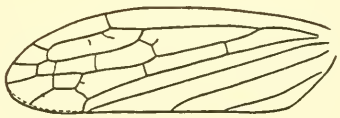
1C

C-CROWN
O-OCELLI
P-PRONOTUM
S-SCUTELLUM

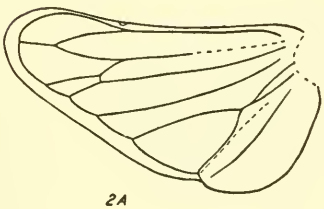
1D



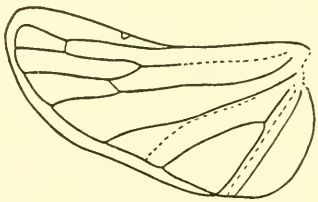
2-BYTHOSCOPUS



3-PACHYOPSIS



2A

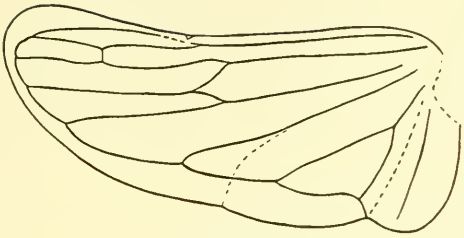


4-ONCOPSIS

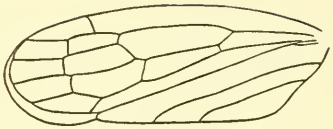
PLATE XXVIII

FIG. 1, hindwing of *Brasa rugicollis* (Dozier) (× 15).
FIG. 2, forewing of *Bythonia rugosa* (Osborn) (× 7).
FIG. 3, hindwing of *Nionia palmeri* (Van Duzee) (× 15).
FIG. 4, forewing, and 4A, hindwing, of *Xestocephalus pulicarius* Van Duzee (× 30).
FIG. 5, forewing of *Arrugada rugosa* (Osborn) (× 8).
FIG. 6, same of *Egenus acuminatus* Oman (× 7).
FIG. 7, same of *Spangbergiella vulnerata* (Uhler) (× 15).
FIG. 8, same of *Bolarga boliviana* (Osborn) (× 15).
FIG. 9, same of *Luheria constricta* Osborn (× 15).

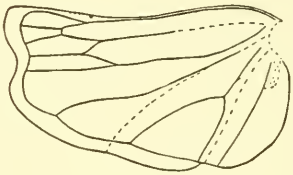
PLATE XXVIII



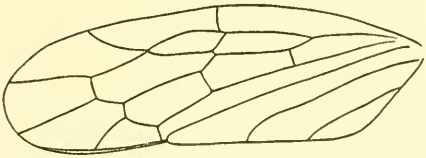
1-BRASA



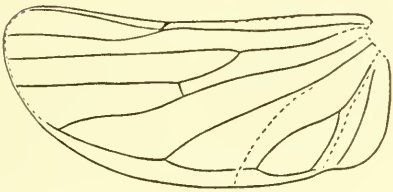
2-BYTHONIA



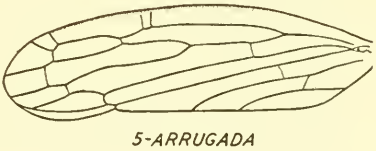
3-NIONIA



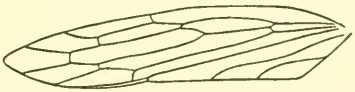
4-XESTOCEPHALUS



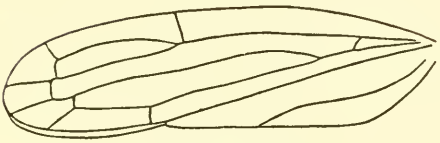
4A



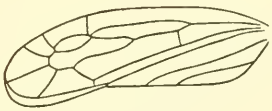
5-ARRUGADA



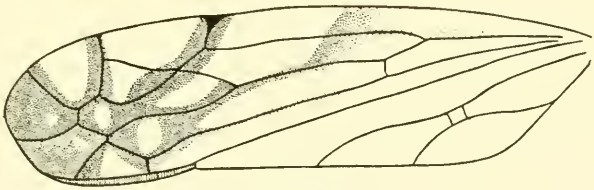
6-EGENUS



7-SPANGBERGIELLA



8-BOLARGA

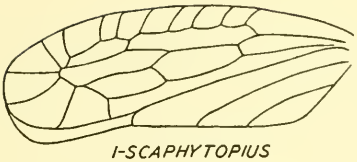


9-LUHERIA

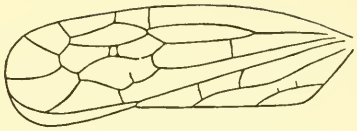
PLATE XXIX

FIG. 1, forewing of *Scaphytopius elegans* (Van Duzee) (× 15).
FIG. 2, same of *Sanctanus sanctus* (Say) (× 15).
FIG. 3, same of *Scaphoidula cingulata* Osborn (× 15).
FIG. 4, same of *Bonamus lineatus* Oman (× 15).
FIG. 5, same of *Bahita infuscata* (Osborn) (× 8).
FIG. 6, same of *Kanorba reflexa* Oman (× 15).
FIG. 7, same of *Garapita garbosa* Oman (× 15).
FIG. 8, same of *Caphodus maculatus* Oman (× 15).
FIG. 9, same of *Agudus typicus* Oman (× 15).
FIG. 10, same of *Hecaloidia nervosa* Osborn (× 15).

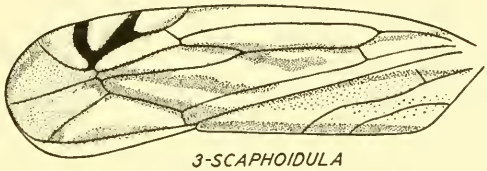
PLATE XXIX



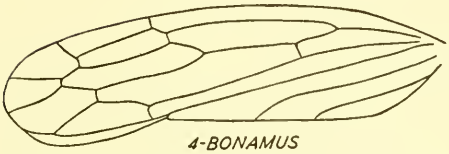
1-SCAPHYTOPIUS



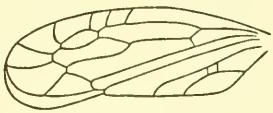
2-SANCTANUS



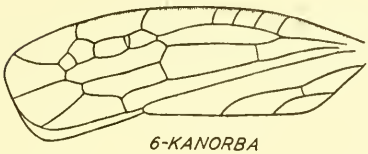
3-SCAPHOIDULA



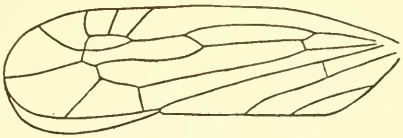
4-BONAMUS



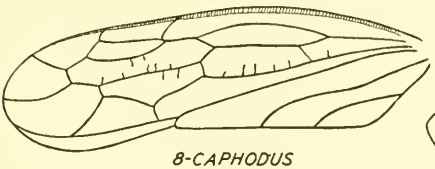
5-BAHITA



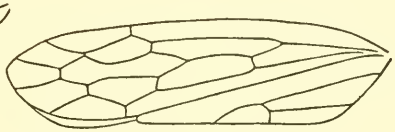
6-KANORBA



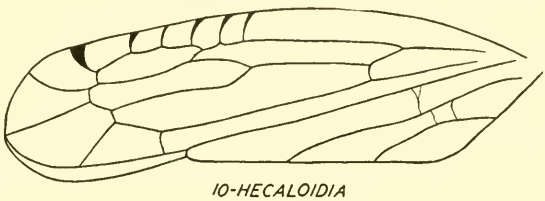
7-GARAPITA



8-CAPHODUS



9-AGUDUS

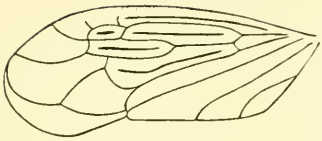


10-HECALOIDIA

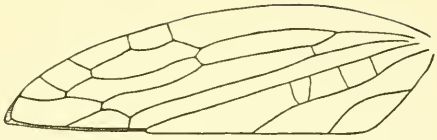
PLATE XXX

FIG. 1, forewing of *Eusceloidia nitida* Osborn (× 15).
FIG. 2, same of *Acinopterus acuminatus* Van Duzee (× 15).
FIG. 3, same of *Neobala pallida* (Osborn) (× 15).
FIG. 4, forewing; and 4A, hindwing, of *Balclutha punctata* (Thunberg) (× 15).
FIG. 5, forewing of *Exolidia picta* Osborn (× 15).
FIG. 6, same of *Cortona minuta* Oman (× 30).
FIG. 7, same of *Idiotettix fasciatus* Osborn (× 8).
FIG. 8, same of *Coelidiana rubrolineata* (Baker) (× 8).
FIG. 9, forewing; and 9A, hindwing, of *Jassus olitorius* (Say) (× 7).

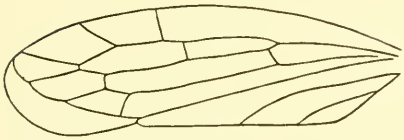
PLATE XXX



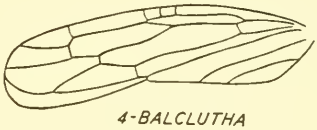
1-EUSCELOIDIA



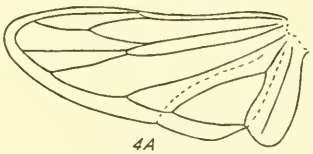
2-ACINOPTERUS



3-NEOBALA

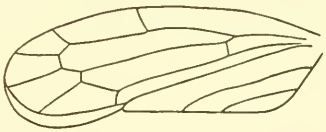


4-BALCLUTHA

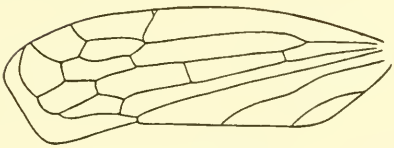


4A

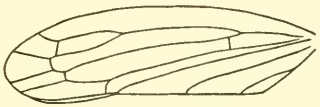
5-EXOLIDIA



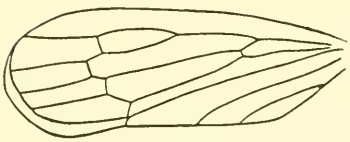
6-CORTONA



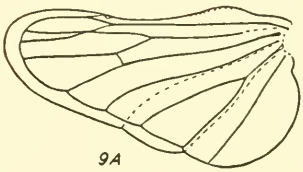
7-IDIOTETTIX



8-COELIDIANA



9-JASSUS

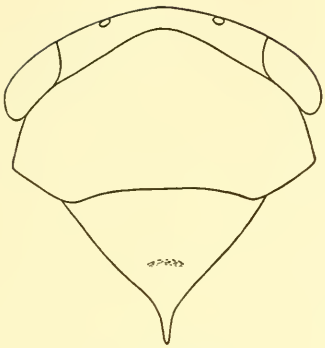


9A

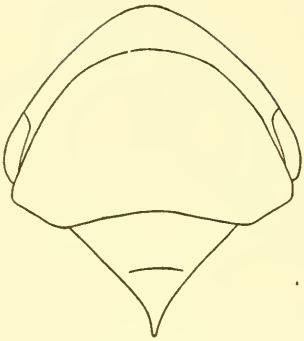
PLATE XXXI

FIG. 1, head and thorax of *Bythonia rugosa* (Osborn) (× 15).
FIG. 2, same of *Nionia palmeri* (Van Duzee) (× 30).
FIG. 3, same of *Xestocephalus pulicarius* Van Duzee (× 30).
FIG. 4, same of *Cariancha cariboba* Oman (× 15).
FIG. 5, same of *Brincardorus laticeps* Oman (× 15).
FIG. 6, same of *Cerrillus notatus* (Osborn) (× 35).
FIG. 7, head and thorax; and 7A, face, of *Arrugada rugosa* (Osborn) (× 15).
FIG. 8, head and thorax of *Luheria constricta* Osborn (× 15).
FIG. 9, same of *Bonamus lineatus* Oman (× 15).
FIG. 10, same of *Egenus acuminatus* Oman (× 15).

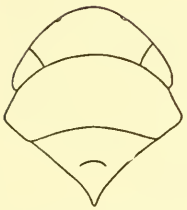
PLATE XXXI



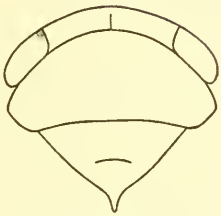
1-BYTHONIA



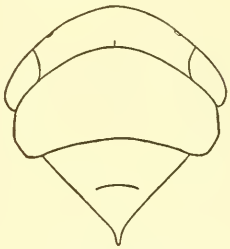
2-NIONIA



3-XESTOCEPHALUS

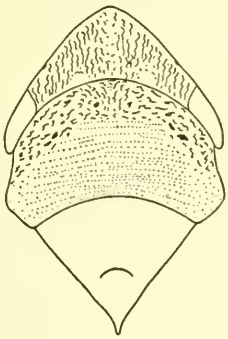


4-CARIANCHA

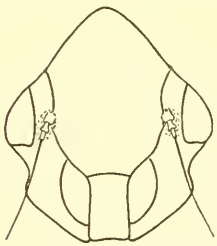


5-BRINCADORUS

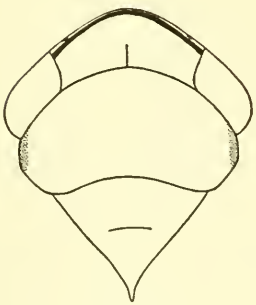
6-CERRILLUS



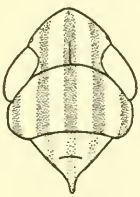
7-ARRUGADA



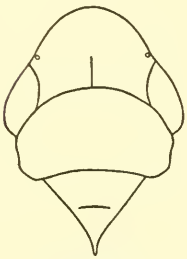
7A



8-LUHERIA



9-BONAMUS



10-EGENUS

PLATE XXXII

FIG. 1, head and thorax of male; and 1A, of female, of *Spangbergiella vulnerata* (Uhler) (× 15).

FIG. 2, head and thorax of *Bolarga boliviana* (Osborn) (× 30).

FIG. 3, head and thorax; 3A, front; and 3B, head in profile, of *Scaphytopius elegans* (Van Duzee) (× 30).

FIG. 4, head and thorax of *Scaphoidula cingulata* Osborn (× 15).

FIG. 5, same of *Sanctanus sanctus* (Say) (× 30).

FIG. 6, same of *Osbornellus auronitens* (Provancher) (× 15).

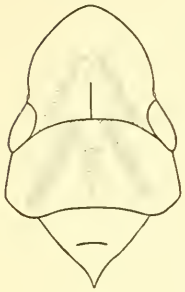
FIG. 7, same of *Garapita garbosa* Oman (× 30).

FIG. 8, same of *Portanus stigmosus* (Uhler) (× 15).

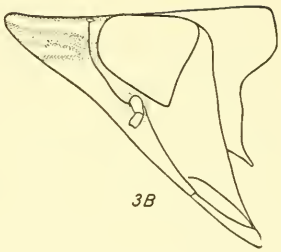
FIG. 9, same of *Agudus typicus* Oman (× 15).

PLATE XXXII

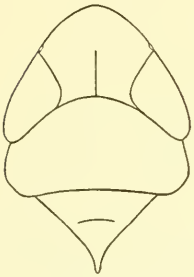
1-SPANGBERGIELLA



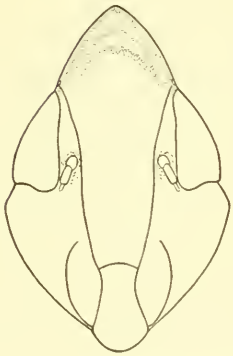
1A



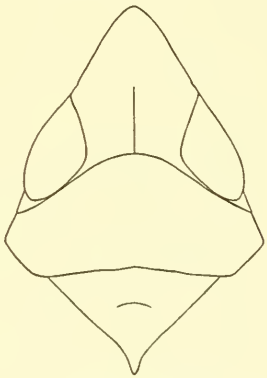
3B



2-BOLARGA

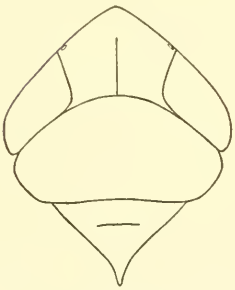


3A



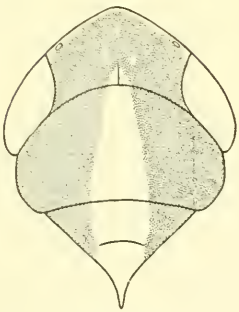
3-SCAPHYTOPIUS

4-SCAPHOIDULA



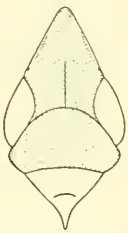
5-SANCTANUS

6-OSBORNELLUS



7-GARAPITA

8-PORTANUS

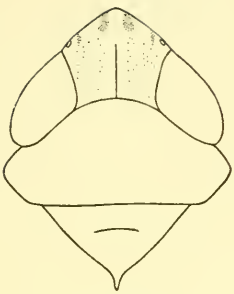


9-AGUDUS

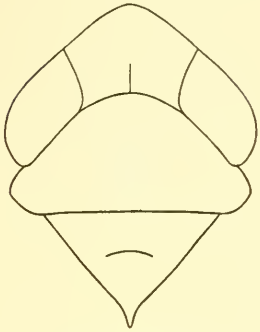
PLATE XXXIII

FIG. 1, head and thorax of *Cumora angulata* Oman (× 30).
FIG. 2, same of *Kanorba reflexa* Oman (× 30).
FIG. 3, same of *Hecaloidia nervosa* Osborn (× 15).
FIG. 4, same of *Caphodus maculatus* Oman (× 30).
FIG. 5, head and thorax; and 5A, face, of *Baroma reticulata* Oman (× 15).
FIG. 6, head and thorax of *Menosoma cincta* (Osborn and Ball) (× 15).
FIG. 7, same of *Atanus dentatus* (Osborn) (× 30).
FIG. 8, same of *Bahita infuscata* (Osborn) (× 15).
FIG. 9, same of *Hegira brunnea* Oman (× 15).
FIG. 10, head and thorax; and 10A, face of *Exitianus obscurinervis* (Stål) (× 30).

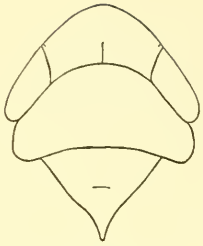
PLATE XXXIII



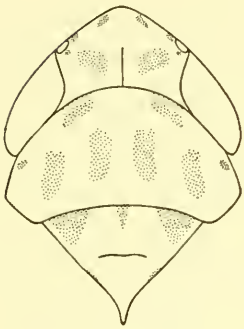
1-CUMORA



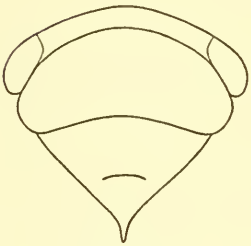
2-KANORBA



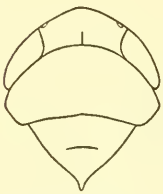
3-HECALOIDIA



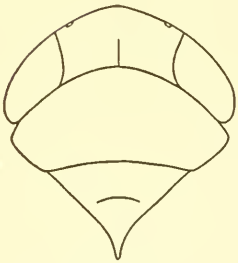
4-CAPHODUS



5-BAROMA

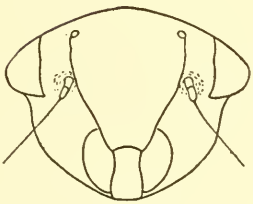


6-MENOSOMA

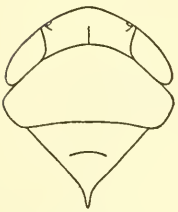


7-ATANUS

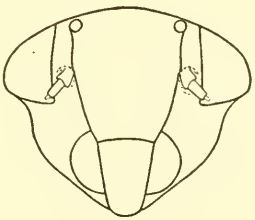
8-BAHITA



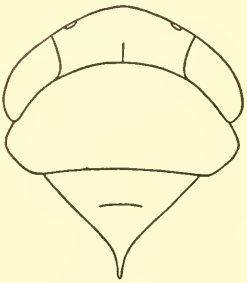
5A



9-HEGIRA



10A



10-EXITIANUS

PLATE XXXIV

FIG. 1, head and thorax; and 1A, head in profile, of *Eusceloidia nitida* Osborn (× 30).

FIG. 2, head and thorax of *Faltala brachyptera* Oman (× 30).

FIG. 3, same of *Brazosa picturella* (Baker) (× 30).

FIG. 4, same of *Alaca longicauda* Oman (× 15).

FIG. 5, same of *Acinopterus acuminatus* Van Duzee (× 15).

FIG. 6, same of *Cortona minuta* Oman (× 30).

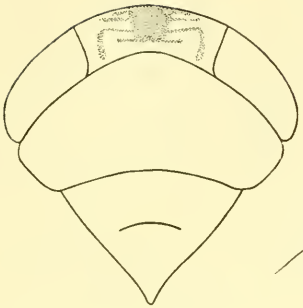
FIG. 7, same of *Onura eburneola* Oman (× 30).

FIG. 8, same of *Chlorotettix unicolor* (Fitch) (× 15).

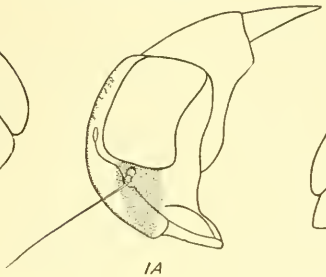
FIG. 9, head and thorax; and 9A, face, of *Stirellus bicolor* (Van Duzee) (× 30).

FIG. 10, head and thorax of *Benala tumida* (Osborn) (× 30).

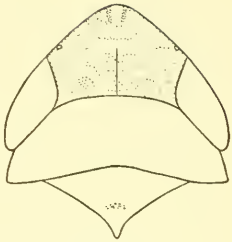
PLATE XXXIV



1-EUSCELOIDIA

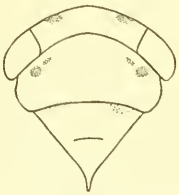


1A

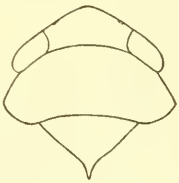


2-FALTALA

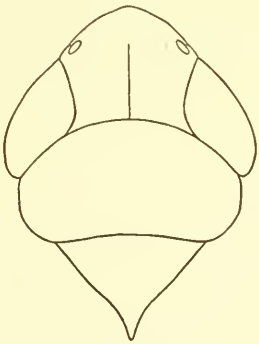
3-BRAZOSA



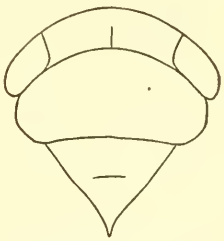
4-ALACA



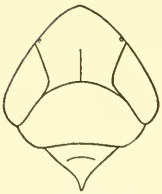
5-ACINOPTERUS



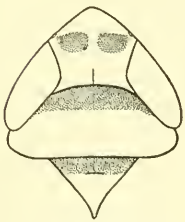
7-ONURA



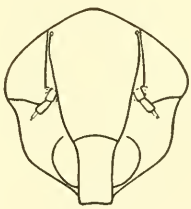
8-CHLOROTETTIX



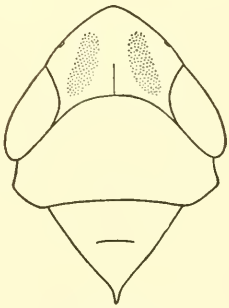
6-CORTONA



9-STIRELLUS



9A



10-BENALA

PLATE XXXV

FIG. 1, head and thorax of *Balclutha punctata* (Thunberg) (× 30).

FIG. 2, same of *Nesosteles hebe* Kirkaldy (× 30).

FIG. 3, head and thorax; and 3A, face, of *Idiotettix fasciatus* Osborn (× 15).

FIG. 4, head and thorax of *Exolidia picta* Osborn (× 15).

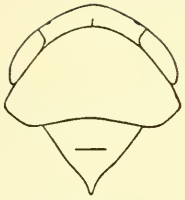
FIG. 5, same of *Conala fasciata* (Osborn) (× 30).

FIG. 6, same of *Coelidiana rubrolineata* (Baker) (× 15).

FIG. 7, head and thorax; and 7A, face, of *Chinaia bella* Bruner and Metcalf (× 15).

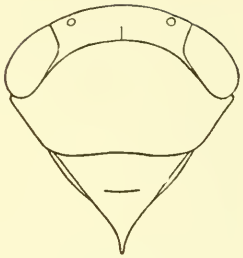
FIG. 8, head and thorax; and 8A, face, of *Jassus olitorius* (Say) (× 15).

PLATE XXXV

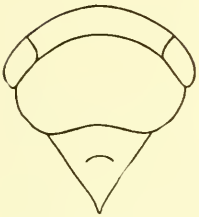


1-BALCLUTHA

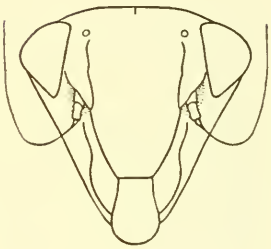
2-NESOSTELES



3-IDIOTETTIX



4-EXOLIDIA



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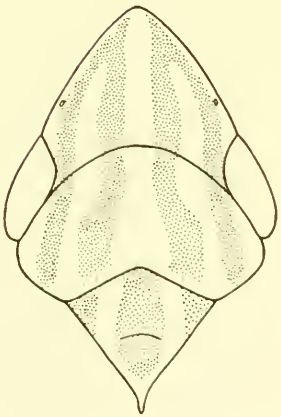

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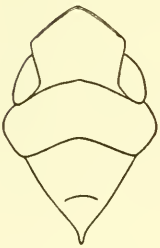

6-COELIDIANA

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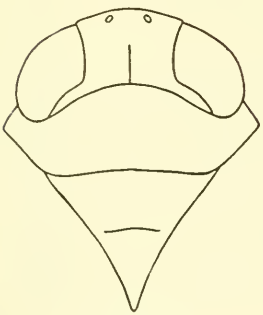

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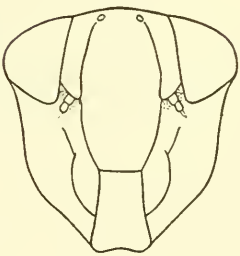

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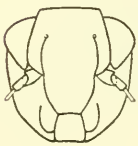

7A

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A Contribution to the Taxonomy of the Subfamily Issinae in America North of Mexico (Fulgoridae, Homoptera)

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PART I

ABSTRACT: This paper comprises the first part of a monograph dealing with the taxonomy of the subfamily Issinae (Fulgoridae, Homoptera) in America, north of Mexico. This section of the study includes only the genus Dictyssa, which is one of the few large genera in the subfamily. Of the ten established species the following five species of Melichar's are redescribed and comparative notes and drawings of structural details are given: *D. areolata, D. mutata, D. fusca, D. clathrata* and *D. marginepunctata*. Comparative notes and drawings are added for four other species; namely, *D. obliqua* Ball, *D. ovata* Ball, *D. fenestrata* Ball, and *D. transversa* Van Duzee. Material of *Dictyssa mira* Van Duzee was not available for study, but this species is included in the key. *Dictyssa semivitrea* Provancher is reduced to synonymy under *Dictyobia permutata* Uhler. The characters of most value for classification are the male genitalia, the shape of the tegmina and the venation of the wings. The following species are described as new: *D. maculosa, D. monroviana, D. quadravitrea, D. beameri* and *D. balli.*

INTRODUCTION

THE purposes in writing this paper are several: First, to assemble under one article all our knowledge to date concerning the taxonomy of the previously described species in this subfamily which occur in America, north of Mexico, since many species have been added to the group after the publication of Melichar's monograph in 1906; second, to make comprehensive keys to the genera and the species; third, to describe a number of new species and redescribe some of the older doubtful species; fourth, to study and figure the male genitalia of all available species, which, as far as the writer knows, has not hitherto been done in the Fulgoridae; lastly,

to present visual aids, such as the drawings of lateral views of the different species, which may help others in identifying the species.

FAMILY CHARACTERISTICS

Antennae placed on the side of the head below the eyes, very variable in shape and size, but usually consisting of two segments terminated by a very fine hair or bristle, rarely with basal appendages (Otiocerus); sense organs on antennae numerous and generally of a complex nature and mostly situated on the second segment; middle coxae articulated considerably apart, allowing for considerable range of movement, as opposed to those of the Cicadoidea, which are closer together and allow for very limited movements; hind coxae immobile and exterior part coalesced with metathorax; no filter present between midintestine and crop; ovipositor, with the exception of part of the Cixiinae, greatly reduced or incomplete, anterior and middle pairs of valves not fastened together by tongue and groove arrangements as in the *Cicadoidea*. Prothorax normally developed and unarmed.

NOTE.—The classification of the family Fulgoridae is today a controversial question. Some Homopterists believe that the family should remain as one family, which in turn is then subdivided into some ten or eleven subfamilies. Others believe that many of these subfamilies should be raised to family rank. Until we have completed more detailed morphological and taxonomic work of the entire group, especially in regard to wing venation and male genitalia, the writer does not feel that it is advisable to make too radical a departure from the generally accepted older view of keeping the family Fulgoridae intact. If this view is held, the family characteristics are the same as the superfamily Fulgoroidea.

SUBFAMILY CHARACTERISTICS

Head not narrower, or only slightly so, than pronotum. Clypeus convex, but not greatly produced beyond plane, its lateral margins not keeled. Pronotum posteriorly subquadrate, anteriorly roundingly produced. Scutellum usually much longer than pronotum. Tegmina in texture either coriaceous, somewhat corneus, or vitreous, either entirely or with vitreous patches; held rooflike over body, their anal margins usually meeting, but sometimes widely separated. Hind wings very variable, being either absent, rudimentary, slight and narrow, or large and ample where they are notched at sides so that they can be folded in three. Hind legs with two to four spines on hind tibiae.

TECHNIQUE AND TERMINOLOGY

The only special technique which might be of interest to describe is that used in studying the male genitalia. Drawings of these structures were made from microscope slides, made in the following way. The specimens were relaxed either in a relaxing jar or by boiling them for a minute or two in hot water. The tip of the abdomen was carefully removed and this placed in 10 percent caustic potash which was heated to the boiling point and sometimes boiled for a moment or two (the exact time required should be tried out by the operator). After boiling in the caustic potash the tip of the abdomen was next placed in glycerine or water for dissection. The dissected parts were then allowed to stand in 95 percent alcohol for a few seconds. From this medium they were immediately mounted in diaphane on the slide. Drawings of the lateral views of the aedeagus, the harpagones and the anal flaps were made from these slides. All other drawings were drawn from the specimens.

The terminology for most of the morphological characteristics was obtained from Snodgrass' textbook "Principles of Insect Morphology" (1936) or Muir's paper, entitled, "On the Classification of the Fulgoroidea" (1923). Special terms used in the descriptions or keys are labeled or indicated on the first drawings of each plate.

THE GENUS DICTYSSA

DESCRIPTION OF THE GENUS

Small, robust insects with hemispherical tegmina which are held vertical to the body and whose greatest width is at tip of clavus or posterior to tip. The apical margin of the tegmen strongly rounding and the costal margin expanded. Vertex extremely short through middle, not produced much beyond eyes, usually depressed through middle and with elevated margins. Pronotum extremely narrow at sides where it tapers to almost a point; its anterior margin deeply emarginate into region of the vertex; its posterior margin shallowly concave. Mesonotum triangular, with or without a median carina present. Frons quadrangular, usually more or less parallel margined, truncate posteriorly, deeply emarginate anteriorly for the insertion of the postclypeus. Postclypeus moderately inflated. Anteclypeus and labrum small. Main veins of tegmen coarse, a network of finer veins between them; median cells or bands of cells frequently hyaline, which contrast sharply with the opaque or darker

outer cells. Wing venation, based on Muir, Tillyard and Snodgrass, show the following general characteristics: vein Sc divided, Sc_1 (= costal vein of Metcalf) running along costal border for at least half the length of the wing; Sc_2 and R united at base and then running more or less parallel with each other to apex where they are lost in the apical reticulation; vein R thus unbranched, as is typical for many Homoptera; vein M typically two branched, sometimes three branches present; vein Cu_1 divided into two branches, Cu_1a and Cu_1b; vein Cu_2 forming the claval suture as in all Homoptera. Hind wings usually absent or rudimentary. Two spines present on hind tibiae.

History of the Genus

To date the following eleven species have been described: *D. semivitrea* Provancher (1889), *D. areolata* Mel. (1906), *D. clathrata* Mel. (1906), *D. fusca* Mel. (1906), *D. marginepunctata* (1906), *D. mutata* Mel. (1906), *D. fenestrata* Ball (1910), *D. ovata* Ball (1910), *D. obliqua* Ball (1910), *D. transversa* Van Duz. (1914), and *D. mira* Van Duz. (1928).

In the opinion of Mr. E. D. Ball (University of Arizona, Tucson) and Mr. Paul Oman (Homopterist, U. S. National Museum) *Dictyssa semivitrea* Provancher is *Dictyobia permutata* Uhler (1889). The author agrees with this viewpoint, as Provancher's written description fits fairly accurately the species known as *Dictyobia permutata* Uhler, and cannot possibly be applied to any known species of Dictyssa. Melichar in his revision of the Issinae evidently mistook *Dictyonia obscura* Uhler (1889) for Provancher's *semivitrea*.

Of the ten known species in the genus the writer has studied types or paratypes of all species except *mira* Van Duz. To this list is being added in the present paper five new species.

Key to the Species

1. Tegmen with no hyaline cells or oblique band across center of corium distinctly separated from darker outer cells 2
   Tegmen with two or more large hyaline cells or an oblique band of hyaline cells across middle of corium, distinctly separated from the other opaque cells 4
2. (1) Entire tegmen translucent with occasional brown spots, elongate; smallest species in the genus; greatest width of tegmen in line with apex of clavus ..... *transversa* Van Duzee, 440
   Tegmen opaque, greatest width at least two thirds of length and posterior to apex of clavus 3
3. (2) Tegmen entirely fuscous, semiopaque; vein M_1+_2 separated at center of tegmen; tegmen broadest just posterior to apex of clavus... *fusca* Melichar, 428
   Tegmen opaque black, with a marginal border of circular hyaline spots; angle in vein R nearer to M_1+_2; vein M_1+_2 simple. *marginepunctata* Melichar, 431

4. (1) Tegmen with hyaline band across corium composed of numerous cells, at least more than five..... 5

Tegmen with three to five conspicuous hyaline cells across corium, in an oblique band..... 7

5. (4) Tegmen with width subequal to length, cells small; greatest width of tegmen in line or slightly anterior to apex of clavus; vein M_1+_2 divided just beyond middle.....*clathrata* Melichar, 430

Tegmen elongate, their greatest width either in line or posterior to apex of clavus; smaller insects..... 6

6. (5) Tegmen with large, angular cells, the hyaline band across corium broad in proportion to opaque part; vein M_1+_2 unbranched and running straight across corium; base of wing greatly narrowed.....*quadravitrea*, n. sp., 441

Tegmen dark blackish-brown; hyaline band of cells composed of many small ones; vein M_1+_2 branched.....*beameri*, n. sp., 443

7. (4) Larger insects, 4.5–5 mm. in length; elytra with oblique bands of fuscous and tan in addition to the vitreous cells..... 8

Smaller insects, usually under 4.5 mm.; bicolored tegmina with vitreous and fuscous cells strongly contrasting..... 9

8. (7) Tegmina thickened, greenish-white with oblique fuscous and pale vittae, *mira* Van Duzee, 427

Tegmina not particularly thickened, pale, clouded with fuscous; distinct large hyaline cells across corium; greatest width beyond apex of clavus; angle of R strongly pronounced so that vein R at this point comes nearer vein M_1+_2 than Sc_2.....*areolata* Melichar, 425

9. (7) Tegmina elongate, the large central hyaline cell of corium at least twice as long as its width; angle in vein R acute, at which point R is nearer vein M_1+_2 than Sc_2..... 10

Tegmina not elongate, the central hyaline cell subquadrate, its length approximating its width; vein R sinuate, making a less distinct angle at end of the central hyaline cell..... 11

10. (9) Tegmina distinctly elongate, its length approximately twice its width, the hyaline cells of corium extremely long, running more lengthwise of wing than in other species.....*balli*, n. sp., 445

Tegmina not twice as long as wide; the central hyaline cell large, extending posteriorly beyond middle to about base of apical fourth, two other conspicuous hyaline cells placed between it and costal border; angle in vein R very acute.....*monroviana*, n. sp., 448

11. (9) Similar to *areolata* in shape of tegmina; central hyaline cell of corium almost circular, the oblique hyaline band abbreviated, not reaching costa; costal border broad; angle in vein R acute and near center of tegmen. *ovata* Ball, 438

Species elongate; the oblique hyaline band with cells irregular in size, reaching completely to costal border; costal border narrow..... 12

12. (11) Brown in general color with two transverse bands of hyaline spots behind middle of tegmina..... 13

Brown with only one transverse band of hyaline spots, the conspicuous hyaline cells across apex lacking..... 14

13. (12) Head and pronotum dark; one transverse row of hyaline cells behind middle in corium of tegmen; hyaline cells across apex of corium large; angle of vein R nearer to vein M_1+_2 than vein Sc_2.....*fenestrata* Ball, 436

Head and pronotum bright yellow; discs of many cells in corium hyaline, the apical hyaline cells not any larger or more conspicuous than others; two transverse rows of hyaline cells beyond middle; angle in vein R equidistant between veins M_1+_2 and Sc_2.....*maculosa*, n. sp., 450

14. (12) Dark tegmina with a yellow or light-colored head and thorax; angle in vein R at about base of apical third of tegmen; vein R at this point equidistant between veins M_1+_2 and Sc_2.....*mutata* Melichar, 433

With a dark-colored head and thorax; angle in vein R located just slightly posterior to middle, vein R at this point nearer to vein M_1+_2 than Sc_2, *obliqua* Ball, 439

Dictyssa areolata Melichar, 1906

Melichar, Leopold. Monographie der Issiden (Homoptera). Abh. k. k. Zool.-Bot. Ges. Wien, III, pt. 4, 1906.

Size. Length of body to tip of tegmen, 3.6 mm. to 4.8 mm. Length of tegmen, 3.5 mm. to 3.9 mm.; width of tegmen, 2.7 mm. to 2.8 mm. This is one of the largest species in the genus.

Color. This is a variegated species in brownish-yellow and dark brown. Head and thorax from above uniformly golden tan or sometimes washed in fuscous. Below thorax light yellow. Abdomen tan, the genitalia frequently brownish. Tegmina variegated in coloring, the oblique hyaline band made up principally of 5 to 6 very large cells with the two central cells subequal and larger than the others and those touching the costal border the smallest of all; these hyaline cells bordered with opaque white and studded around entire margins by dark spurs of veins; anterior to the hyaline band the tegmen is golden brown shaded to very dark brown at base, the costal border at base whitish-yellow crossed by dark, elevated veinlets; posterior to hyaline band is a very dark brown area, occupying apical half of clavus, then extending on to corium where it ends as the posterior dark border of the large central cell; after this dark band occurs a much lighter band, starting just posterior to apex of clavus as a cluster of about 5 small white cells, then becoming a transverse band of light brown and ending at the more posterior hyaline discal cell; finally apex of corium pitch brown, studded all around apical border with semicircular and elongate white, subhyaline spots and sometimes in addition a cluster of three small round hyaline cells in the region of cell M_{1+2} anterior to the border.

Structural characteristics. Vertex extremely broad and short, depressed through middle, its lateral margins anteriorly converging, its length on median line approximately half length of pronotum at middle. Greatest width of eyes less than half the width of vertex. Frons with lateral margins subparallel although bulging slightly next to eyes, all its margins sharply elevated, median carina very distinct but disappearing before reaching clypeus.

Postclypeus with posterior margin angularly produced into the frons for a distance equal to about one fourth the length of the latter. Pronotum with anterior margin sharply elevated, roundingly produced and its posterior margin very shallowly concave; its length through middle approximately one half the length of the mesonotum at middle; a median carina only faintly visible if at all; two small round depressed spots on disc, one on each side of median line. Mesonotum with only a very faint median carina present, a transverse groove following anterior margin but stopping at either side before reaching lateral margin. Tegmina one fourth longer than wide, their greatest width posterior to apex of clavus, hemispherical in outline, with oblique hyaline band across disc made up of 4 to 5

large cells, the largest one being the central one located between veins M and R, another one almost equaling it in size, posterior and ventrad of it between R and Sc, a large one in the anal region extending to the clavus, and one or two small ones touching costal border; across apex of tegmen large elongate hyaline spots alternating with small semicircular ones; the costal border expanded at base with round or rectangular spots in the cells between the veinlets; vein R making almost right-angled bends, extending very close to M_{1+2} so that the space between veins R and Sc_2 is about 3 times the distance between R and M_{1+2}; vein M_{1+2} single.

Male genitalia. Anal flap (10th abdominal segment) in width about twice as wide as long, its posterior margin truncately emarginate. Eleventh segment scarcely visible, its dorsal stylus long and conspicuous.

Harpagones (genital styli), visible externally as two-pointed plates exceeded by anal tube for a short distance. From a flattened lateral view (see drawing 25, plate XLI) each harpago is roughly quadrangular, broadest through apical third, the dorsal margin of this region extended dorsad into a short, recurved hook, another small broad hook or flap just anterior to the latter.

The aedeagus as viewed from the right side is a long tube partially sclerotized, bearing a short recurved lateral hook attached slightly posterior to middle, and two large ventrad-curving basal hooks, the apical halves only of which extend beyond the theca. On the left side a short blunt hook is attached at middle. The theca in this species extends over about the basal third of the aedeagus; on the right side its posterior margin is truncate and on the left side posteriorly it is extended into a heavily sclerotized, strongly recurved hook which simulates the appearance of the thecal hooks.

Female genitalia. Anal flap (10th abdominal segment) broad, roundingly pointed posteriorly. The external valves of the ovipositor widest at a point about midway of their length, their combined width greater than their length.

Comparative notes. This species is an easily recognized species externally by both color and structure. The variegated or mottled tan and brown of the tegmina and the cluster of small white spots in the region of cell M_{1+2} in addition to the usual oblique and apical bands separate it very distinctly. It is the largest species in the genus, excepting *D. mira* Van Duzee. It differs from all other species in the genus by having vein R bend at almost an acute angle and coming so close to M_{1+2} that the space between veins R and

Sc_2 is about three times the distance between R and M_{1+2}. The male genitalia are characteristic and distinctive for the species. (See plate XXXVIII, drawings 4a and 4b.)

Notes on distribution. This species was described from males collected at Los Angeles, Cal. The type is located in the museum at Washington. Since this species has been wrongly determined, drawings of the type are figured on plate XXXVI as well as that of a specimen recently collected. A large series of this species has been collected by R. H. Beamer from Monrovia, Cal., in July.

Dictyssa fusca Melichar, 1906

Melichar, Leopold. Monographie der Issiden (Homoptera). Abh. k. k. Zool.-Bot. Ges. Wien, III, pt. 4, 1906.

Size. Length of body to tip of tegmen, 3.3 mm. Length of tegmen, 2.85 mm.; width of tegmen, 2.4 mm.

Color. Most of body and tegmina uniform testaceous brown, occasionally with one or two small hyaline cells in corium of tegmen. Thorax light tan shaded with brown. Abdomen dark testaceous brown. Legs tannish to brown.

Structural characteristics. Vertex characteristic for the genus, very broad and short, length through middle approximately one half of pronotum at middle. Greatest width of eyes slightly over one third the width of the vertex. Front, parallel-margined, its greatest width through middle; the median carina distinct. Pronotum exceeded at sides by eyes. Mesonotum over one third longer than pronotum, a distinct transverse groove near anterior end and a faint median carina present but not reaching apex. Tegmina semiopaque, not much longer than wide, their greatest width just posterior to apex of clavus at which region they are distinctly inflated; the veins coarse, outlining small cells, the costal margin at base considerably reflexed; venation characteristic for the species with vein R not angled but merely rounding, distinctly nearer Sc than M, vein M forked very near base, vein M_{1+2} separating into M_1 and M_2 slightly posterior to middle of tegmen, vein M_{3+4} simple, curving more toward Cu_{1a} than in most species except *D. fusca*.

Male genitalia. Anal flap which is an external ventral extension of the tenth abdominal segment, not quite twice as long as broad, slightly bilobed at tip. Eleventh abdominal segment scarcely visible, its dorsal stylus long and slender.

Harpagones (genital styli of authors) visible externally on ventral side as two broad, platelike lobes, but which appear to be dovetailed into abdomen more than in most species. From a flattened lateral

view (see drawing 21, plate XLI) each harpago is subquadrangular and has its posterior dorsal corner prolonged dorsad into a slender process recurved at tip around aedeagus, a short broad spine or hook placed externally at the base of this dorsal extension. The aedeagus is distinctly different from *clathrata* and other species. Unfortunately the drawing is a composite one made from a poor slide, yet the differences are so distinct that it leaves little doubt as to this being a distinct species.

The aedeagus as viewed from the right side is a long slender tube bearing one long recurved hook midway of its length and a two-hooked extension attached at its extreme base, these hooks showing beyond the theca as two equal, adjoining and heavily sclerotized hooks which curve only slightly dorsad. As viewed from the left side the tips of the three hooks only are visible. The theca is a semimembranous tube, covering about one half of the aedeagus at its base. As viewed from the right side it has a truncate, posterior margin and from the left side has its ventral region extending more caudad into a broad truncate flap. (See drawings 2a and 2b, plate XXXVIII.)

Female genitalia. Anal flap (10th segment) as drawn attached to specimen about twice as long as broad with the genital stylus long and slender. The external valves of the ovipositor as viewed from the ventral side are broadest at a point from base which is about three-fourths of the total length of the valves, their combined widths at this point greater than the length of the valves.

Comparative notes. This species is distinguished externally from all other species by the uniform dark-brown color, the small size of the cells of the tegmen, the characteristic broadness of the tegmen and the forking of vein M_{3+4}. It more closely resembles *D. clathrata* than any other species, but it differs externally from this species by lacking the hyaline cells in the corium and by having vein M separated near base of wing and vein R distinctly nearer to Sc_2 than M. The male genitalia easily distinguish this species from all other species and are especially significant in separating it from *D. clathrata.*

Data on distribution. Melichar lists this from California. The data on paratype material assigns this species to Placer county, California, collected in October. Perhaps the lateness of the season accounts for the scarcity of specimens. It appears to be the rarest species in the genus.

Type specimens are located in the U. S. National Museum at Washington, D. C.

Dictyssa clathrata Melichar, 1906

Melichar, Leopold. Monographie der Issiden (Homoptera). Abh. k. k. Zool.-Bot. Ges. Wien, III, pt. 4, 1906.

Size. Length of body to tip of tegmen, 3.3 mm. to 3.6 mm. Length of tegmen, 2.7 mm. to 3.15 mm.; width of tegmen, 2.25 mm. to 2.7 mm.

Color. Body pitch brown except the ventral side of thorax, which is light brown. Margins and faint median line of vertex tan. Margins of pronotum darker brown than disc. Margins and carinae of mesonotum tan. Median carina of frons and clypeus tan, rest of frons pitch brown, clypeus somewhat lighter. Tegmina typically pitch brown except for oblique band of hyaline or milky, semitransparent cells across clavus and corium and 5 small, round, whitish, semitransparent cells along extreme apical margin. Legs pitch brown.

NOTE.—Variation in color occurs in this species to the extent of the head and thorax being golden brown as opposed to pitch brown of the tegmina or sometimes the latter also become golden brown likewise.

Structural characteristics. Vertex broad and short, length through middle one half the length of pronotum at middle. Greatest width of eyes approximately one half the width of the vertex. Frons with lateral margins parallel, its length along middle equal to the length of the postclypeus; the median carina distinct, running into a faint transverse carina which does not reach to lateral margins. Mesonotum not quite twice as long as pronotum on median line; a distinct transverse groove along anterior border which does not reach to the lateral margins; a faint median carina present and two lateral carinae faintly indicated. Tegmina semiopaque, somewhat inflated, approximately one ninth longer than wide, their greatest width in line with apex of clavus; the veins coarse, outlining small cells, the costal margin narrowly expanded on basal half; venation characteristic of the species with vein R not angled but merely rounding, distinctly nearer to M_1 than Sc_2, vein M forked only slightly anterior to middle, vein M_{1+2} separated posterior to middle, vein M_{3+4} curving more toward Cu_{1a} than in most species.

Male genitalia. Anal flap (10th segment) not quite twice as broad as long, slightly notched at tip. The eleventh segment slightly visible, its dorsal stylus approximating it in length.

Harpagones (genital styli) visible externally on ventral side as two slenderly pointed flaps, the rest of the abdomen showing considerably beyond them. From a flattened lateral view (see drawing 20, plate XLI) each harpago is roughly quadrangular but has

its posterior, dorsal region extended into a slender process, truncate at tip and only slightly curved, the whole process being shorter than that of D. *fusca*. At the base of this dorsal extension is a slender, pointed ventrad curving external hook.

The eadeagus as viewed from the right side is a curved tubular structure bearing a short slender pointed hook midway of its length and a broad, well sclerotized hook attached near its base but extending well beyond the theca almost to the tip of the aedeagus. On the left side the aedeagus bears no hooks. The theca as viewed from the right side extends a little beyond the basal third of the aedeagus and is truncate anteriorly. From the left view it appears as an elongate broad flap, extending almost to apex of the aedeagus.

Female genitalia. Anal flap (10th segment) as drawn on specimen broader through basal half and tapering slightly to a truncate apex. The external valves of the ovipositor very broad in proportion to length, their greatest width being just slightly posterior to the middle.

Comparative notes. This species is separated externally from the majority of species by its very broad and characteristically shaped tegmina, and the small cells in the wing and especially those making up the hyaline or light band. It clearly resembles *D. fusca* Melichar in size and shape of tegmina. It is separated externally from the latter by the presence of the oblique band of hyaline cells and the apical row of five round white cells as well as by the fact that the greatest width of each tegmen is anterior to the apex of the clavus in *clathrata* but posterior in *fusca,* and that vein R is distinctly nearer to vein M than Sc_2 and vein M is separated only slightly anterior to middle. The male genitalia distinctly separate this species from every other member of the genus.

Notes on distribution. Melichar lists this species from California. Recently specimens have been taken by Mr. Paul Oman and R. H. Beamer from Redding, Cal., in June, and from Sacramento county, California, by L. D. Anderson in August. The author had available for study 8 specimens. Apparently this species, like *fusca,* is not a common one.

Dictyssa marginepunctata Melichar, 1906

Melichar, Leopold. Monographie der Issiden (Homoptera). Abh. k. k. Zool.-Bot. Ges. Wien. III, pt. 4, 1906.

Size. Length of body to tip of tegmen, 3.15 mm. to 3.5 mm. Length of tegmen, 2.7 mm. to 2.85 mm.; width of tegmen, 1.8 mm. to 2.1 mm.

Color. This is the darkest species in the genus. Body color is dark brown except for light brown or yellow on margins and median stripe on vertex, median carinae and lateral and posterior margins on pronotum and mesonotum, median carina of frons and two spots on gena, one dorsad of antenna and one ventrad. Tegmina uniform blackish-brown, the conspicuous veins lighter or even reddish and a conspicuous row of semitransparent white spots, numbering about twelve to fifteen, sometimes practically uniform in size, in other specimens alternately small and large, those in the costal margin rectangular and crowded together. Legs blackish-brown.

NOTE.—One color variation is noted in some specimens, namely a bright yellow head or thorax contrasting sharply with the pitch-black tegmina.

Structural characteristics. Vertex characteristically broad and short, slightly more than twice as broad as greatest width of eye, length through middle about half length of pronotum. Frons broad, subequal in length and width, with a distinct, well-elevated median carina. Pronotum with a faint median carina and laterad of it on either side a small circular depression. Mesonotum with a faint median carina and in center of each lateral third a shallow depression. Tegmina coriaceous with distinct elevated veins, their greatest width on a line even with apex of clavus, their posterior margins evenly rounding, the costal margin somewhat expanded at base; venation characteristic of the species with the angle in vein R indicated but not pronounced and vein R at this point closer to vein M_{1+2} than Sc_2, mainly due to the fact that the latter runs nearer middle of tegmen; vein M_{1+2} single.

Male genitalia. Anal flap (10th segment) slightly broader than one half its length, with its apical margin shallowly emarginate. The eleventh segment not always visible, its dorsal stylus an elongate fingerlike lobe.

Harpagones (genital styli) from an external ventral view broad at base and tapering at their apices, not much of abdomen visible beyond them. From a flattened lateral view (see drawing 19, plate XLI) each harpago is roughly quadrangular with its posterior dorsal corner extended into a short, sharply pointed process, at base of which is a broad, shallow, small external hook.

The aedeagus as viewed on the right side is a long, curved tubular structure bearing a sharply pointed sclerotized hook attached at a point from apex of aedeagus, which equals in distance about one fourth the total length of the aedeagus and shows the apices of two heavily sclerotized, sharply pointed basal hooks, one of which ex-

tends beyond the theca a little more than twice as far as the other does. On the left side the aedeagus bears an apical hook which is attached at a point from apex of aedeagus that equals in distance about one third the total length of the aedeagus. The two basal hooks show again from this view. The theca on the right side extends over the aedeagus not quite half its length and is angularly produced on posterior margin. On the left side the theca is extended posteriorly into a finely tapering spinelike process. (See drawings 11a and 11b, plate XXXIX.)

Female genitalia. Anal flap (10th segment) broadest through middle, suddenly tapering to a roundingly pointed apex. The external valves of the ovipositor very broad in proportion to length, their greatest width being just slightly posterior to the middle.

Comparative notes. In size and shape of tegmina very similar to the *obliqua* and *mutata* group. It differs from these species by the uniform dark-brown tegmina with the sharply contrasting white apical and costal spots and the small cells throughout the length of the tegmina. It differs from other species by the characteristic shape of the tegmina. The male genitalia definitely distinguish it from other species.

Notes on distribution. Melichar lists this species from California. It is described from a female specimen which is in the Signoret collection in Wien, Austria. The author studied nine specimens collected in San Diego county, California, by Paul Oman, and at Campo, Beaumont and Jacumba, Cal., by R. H. Beamer in July and August.

Dictyssa mutata Melichar, 1906

Melichar, Leopold. Monographie der Issiden (Homoptera). Abh. k. k. Zool.-Bot. Ges. Wien, III, pt. 4, 1906.

Size. Lenth of body to tip of tegmen, 3 mm. to 3.3 mm. Length of tegmen, 2.4 mm. to 2.7 mm.; width of tegmen, 1.8 mm.

Color. Head, pronotum and scutellum uniform pale-yellowish or brownish-yellow. Thorax tawny yellow. Abdomen somewhat darker yellow washed in brown, especially at lateral carinae and on the genitalia. Legs, tawny yellow. Tegmina with wing pattern characteristic of the *mutata-obliqua* group. In this species the vitreous, oblique band of cells starts at base of clavus, runs posteriorly slightly beyond middle, then bends abruptly ventrad, ending in the costal margin. The central hyaline cell located between veins M and R is much larger than any other cell in wing, is distinctly

ovate in shape, its posterior boundary situated two thirds of the wing length from the base of the wing, its margins studded with 5 to 9 short, dark spurs of veins. The second largest hyaline spot lies dorsad and cephalad of the central cell, a group of small, roundish hyaline cells, varying in number from 2 to 5, or else one large cell, adjoin the central cell at its caudo-ventral angle, and beyond these on the costal border is a median-sized elongate pellucid cell. The entire apical and costal margins of the tegmen are studded by pellucid disclike or semicircular spots which are not uniform in size but which frequently alternate between large and small ones.

Structural characteristics. Vertex broad and short, length through middle one half the length of the pronotum. Greatest width of eyes one half the width of vertex. Pronotum with anterior margin roundingly produced and its posterior margin shallowly concave; its length through middle one half the length of mesonotum at middle; the median carina not present or only faintly discernible; two small, depressed, round spots on disc, one on each side of median line. Mesonotum with no median carina distinctly visible; a shallow depression in disc on each side of median line and a transverse groove at base of apical prolongation. Frons, subequal in length and width, parallel-margined, the median carina very distinct but fading away before reaching postclypeus. Postclypeus with posterior margin angularly produced into frons for a distance equal to about one third of the total length of the latter. Tegmina approximately one fourth longer than wide, their greatest width posterior to apex of clavus showing a great contrast between the hyaline cells and the opaque brown cells, both in texture and size; the largest cell in the wing, located on disc of corium between veins R and M, is in length approximately about one third the total length of the tegmen, and its width is approximately two thirds of its length, although its size is subject to some variation; veins of the tegmen coarse, outlining cells of varying sizes; the costal margin moderately expanded; wing venation characteristic of the species with a distinct angle in vein R, located more posteriorly than in some species, at a point approximately at base of apical third of wing, the area between R at this point and vein M_{1+2} equal to space between R and Sc_2; vein M_{1+2} single.

Male genitalia. Anal flap (10th abdominal segment), its width approximately two thirds of its length, its posterior margin truncate. Eleventh segment scarcely visible, its dorsal stylus a short finger-like projection.

Harpagones (genital styli) visible externally as two triangular plates, not much of abdomen visible beyond their apices. From a flattened lateral view (see drawing 22, plate XLI) each harpago is subquadrangular and has its posterior dorsal corner prolonged dorsad into a sharply pointed short process, at base of which is a recurved short broad external flap.

The aedeagus as viewed from the right side is a long slender tube bearing a slender, sclerotized, sharply pointed projection attached at the base of its apical third and two basal hooks, the apical half only of which shows beyond the theca. These latter two hooks are of unequal size, the dorsal one very slender and sharply pointed, the ventral one broad at base and gradually tapering to a recurved slender tip. On the left side the aedeagus bears an apical projection also, but this one is attached nearer to the middle of the aedeagus. The theca envelops the aedeagus at its base not quite half its length. On the right side it is truncate posteriorly. On the left side it extends posteriorly as a sharply pointed, slightly sclerotized spine, which very easily can be missed, since a process of the aedeagus usually covers it.

Female genitalia. Anal flap as drawn while attached to specimen approximately one third longer than wide, tapering posteriorly to a roundingly pointed apex. The eleventh segment and dorsal stylus approximately very small. The external valves of ovipositor broadest at a point about midway of their length, their combined width much greater than their length.

Comparative notes. This species is quite easily separated from the majority of the species in the genus by the presence of the large central hyaline cell. Other species in the genus having a large central cell likewise are *D. areolata, D. obliqua, D. fenestrata, D. ovata* and *D. balli.* From *D. areolata* it is easily separated by the much larger size of body of *areolata* and by the fact that vein R in the latter is so far removed from Sc. From *D. fenestrata* it is likewise easily separated by lacking the second transverse band of hyaline cells across apex and by having the angle of vein R not as close to M_{1+2} as in that species. *D. balli* is easily distinguished from other species by its elongate form and very long central cell between veins R and M. In *D. ovata* the hyaline band does not reach the costal margin and the angle in vein R is very near the middle of the wing, both of which characters are distinctly different from *mutata.* From *D. obliqua* and *D. monroviana, mutata* is not so easily distinguished. In fact, these three species seem to be repre-

sentatives of a rather unstable group in the genus, for specimens of various localities show any number of variations in the cells and veins of the tegmina. The writer believes that *D. mutata* and *D. obliqua* are both good species, since their genitalia are distinctly different. Externally the only distinguishable characters are the color of the head and thorax, which is yellow in *mutata* and dark in *obliqua*, and the angle of vein R being at base of apical third of tegmen in *mutata* but nearer the middle in *obliqua*, while vein R is equidistant from vein Sc_2 and vein M_{1+2} in the former and nearer M_{1+2} in the latter. Any number of gradations from these typical types can be found. The writer took only the form differing most widely from either of these forms, both in genitalia and external characters, and described it as a new species, namely *monroviana*. If typical examples of all three species are compared *monroviana* shows a noticeable difference in the tegmina by having much larger hyaline cells on both the discal area and apical margin. It is separated, furthermore, from *obliqua* by having the angle in vein R located as in *mutata* at base of apical third. It is separated from *mutata* by having R nearer vein M_{1+2} than vein Sc, as in *obliqua*.

Notes on distribution. The species was described from a male taken in Los Angeles county, California, and one at Claremont, Cal., collected by Baker. The former type is in the U. S. National Museum and the latter in Melichar's collection. This seems to be a common species. Specimens are at hand for study from San Bernardino, Cal., collected by Coquillet, and the following places in California, collected by R. H. Beamer in August: Big Bear Lake, San Jacinto Mountains, Beaumont and Orange county.

Dictyssa fenestrata Ball, 1910

Ball, E. D. New Genera and Species of Issidae. Proc. Biol. Soc. Wash. XXIII, pp. 41-46, 1910.

Comparative notes. D. fenestrata belongs in the *mutata-obliqua* group, which it resembles in shape of tegmina and size. Its measurements are as follows: length from tip of head to apex of tegmina, 3 mm. to 3.4 mm.; length of tegmen, 2.7 mm. to 2.9 mm.; width of tegmen, 1.8 mm. to 1.9 mm. This species is separated from other species by the following characteristics: the elongate tegmina, which are widest at a point some little distance back of apex of clavus, the uniform brown color of tegmina with lighter veins, the extremely large hyaline cells and spots across apex and in the oblique band of clavus and corium, and the presence of a transverse band of hyaline cells, numbering 5 or 6, just back of middle of

corium which no other species possesses; an acute angle is present in vein R just posterior to middle, at which point this vein is much closer to M_{1+2} than Sc_2, vein M_{3+4} sometimes is crowded toward clavus so that it coalesces with or obliterates the tip of vein Cu_{1a}, and vein Cu_1 is usually two-branched.

Male genitalia. Anal flap (10th abdominal segment) twice as long as wide, only slightly emarginate at apex. Eleventh segment small and usually invisible, its dorsal stylus large and conspicuous.

Harpagones (genital styli) visible externally as two pointed triangular plates, the anal flap visible a short distance beyond their apices. From a flattened lateral view (see drawing 15, plate XLI) each harpago is subquadrangular in shape, narrowed at base, bulging at middle, and with the posterior, dorsal angle prolonged dorsad as a short, bluntly pointed projection, at base of which is a short, recurved, external hook.

The aedeagus is a slender, tubular structure, its apex curving toward its base in such a way as to almost outline a complete circle. On the right side it bears a flattened, very sharply tapering projection attached at about base of apical third and which extends to apex of the aedeagus. At base the latter bears also two heavily sclerotized hooks, of which only the apices show beyond the theca, the dorsal one of these hooks curving slightly dorsad, the ventral one almost straight and extending beyond theca for only half the distance that the other one does. On the left side the aedeagus bears another flattened, tapering projection which is attached at base of apical third and extends to apex of aedeagus. The theca envelops the aedeagus for approximately one third its length. On the right side the posterior margin is truncate. On the left side its posterior dorsal angle extends posteriorly as a sharply pointed process closely adpressed to the side of the aedeagus.

Female genitalia. Anal flap partially covered at base by ninth abdominal segment, roundingly pointed at apex. The eleventh segment inconspicuous and bearing a slender dorsal stylus. The external valve of ovipositor broadest through middle, the length approximately one and one half times its width.

Notes on distribution. Doctor Ball described this species from six specimens collected at Tia Juana, Cal. The author greatly appreciated the gift of one type for study and from which the drawings have been made. Mr. Paul Oman of the United States National Museum collected a series of twenty-two specimens from Del Mar, Cal., on June 2, 1935.

Dictyssa ovata Ball, 1910

Ball, E. D. New Genera and Species of Issidae. Proc. Biol. Soc. Wash. XXIII, pp. 41-46, 1910.

Comparative notes. This is one of the broader species in the genus, with the following measurements: from tip of head to apex of tegmina, 3.3 mm. to 3.6 mm.; length of tegmen, 2.85 mm. to 3.15 mm.; width of tegmen, 2.1 mm. to 2.5 mm. It is easily separated from other species by the following characteristics; the circular shape of the tegmen with the very broadly expanded costal area, the abbreviated oblique hyaline band which does not reach the costal margin, and the almost circular central hyaline cell of this band between veins R and M, caused by vein M curving toward anal region and vein R toward the costal margin; a distinct angle present in vein R very near middle of wing, at which point R is much nearer to vein M_{1+2} than vein Sc_2; vein Sc_2 breaking up into a network of veins at a point midway of the length of the central cell.

Male genitalia. Anal flap (10th abdominal segment) very long, more than twice as long as wide, its posterior margin shallowly emarginate. Eleventh segment, short and inconspicuous, the dorsal stylus proportionally long and prominent.

Harpagones (genital styli) visible externally as two-pointed triangular plates, the anal flap visible for considerable distance beyond their apices. From a flattened lateral view (see drawing 17, plate XLI) each harpago is subquadrangular in shape, much more broadened across apical region than in most species, the posterior dorsal angle drawn out into a recurved projection, ventrad of which is a short, recurved, external hook.

The aedeagus is a much curved, tubular structure, bearing on the right side a sharply tapering flattened process which is broadly attached at base of apical third and two basal heavily sclerotized hooks, whose ventrad curving apices show considerably beyond the theca, the ventral one of the two about two thirds as long as the dorsal one. On the left side the aedeagus bears a sharply pointed flattened process attached slightly posterior to middle. The theca envelops the aedeagus for about half its length. On the right side its posterior margin is truncate. On the left side its posterior dorsal angle extends caudad as a sharply pointed projection to a point at about base of apical third of the aedeagus.

Female genitalia. Anal flap broad at base, roundingly pointed at apex. Eleventh segment inconspicuous, bearing a slender dorsal

stylus. External valves of ovipositor longer than in most species, their combined width not much greater than their length, their greatest width at base of apical third.

Notes on distribution. Doctor Ball described this species from eight examples from Tia Juana, Mexico, and Tia Juana, Cal. He very kindly gave the author a type male and female for study. This seems to be a very rare species.

Dictyssa obliqua Ball, 1910

Ball, E. D. New Genera and Species of Issidae. Proc. Biol. Soc. Wash., pp. 41-46, 1910.

Comparative notes. This species is a trifle larger than *D. mutata,* measuring 3.3 mm. to 3.6 mm. from apex of head to tip of tegmina, and each tegmen 2.7 mm. to 3 mm. long and 1.8 mm. to 2.1 mm. wide. It is separated from the various species in the genus by the following characteristics; a dark-brown head and thorax, margined in yellow; its tegmina about one fourth longer than their width, their greatest width at a point even with apex of clavus or just slightly posterior, the hyaline oblique band of cells across corium and the apical row of semicircular or elongate ones arranged as, and similar in size to, those in *D. mutata*; the venation of these two species, however, differing in that *D. obliqua* has the angle of R more anterior than *D. mutata,* located just slightly posterior to middle and vein R is usually nearer to vein M_{1+2} than Sc_2, while in *D. mutata* it is about equidistant from veins R and Sc_2; vein M_{1+2} single. For further comparative notes see the discussion under this heading in the description of *D. mutata.*

Male genitalia. The genitalia are distinctive for this species. Anal flap (10th abdominal segment) elongate, not quite twice as long as width, its posterior margin shallowly emarginate. Eleventh segment inconspicuous, its dorsal stylus small.

Harpagones (genital styli) visible externally as two pointed triangular plates, the anal flap visible for some distance as viewed from the ventral side, beyond their apices. From a flattened lateral view (see drawing 26, plate XLI) each harpago is subquadrangular in shape, its basal half somewhat narrowed, the posterior dorsal angle prolonged dorsad into a short, sharply pointed projection, at base of which is a short, broad, recurved external hook.

The aedeagus as viewed from the right side is a long, much curved tubular structure, bearing a sharply pointed flat projection attached at approximately the base of its apical fourth and two basal hooks,

whose apices show beyond the theca, the ventral one shorter and curved slightly dorsad, the other one extending beyond the thecal margin twice as long as the other one and curved ventrad at tip. On the left side the aedeagus bears a pointed flat projection attached at about base of apical third. The theca envelops the aedeagus at base for not quite half of its length. On the right side it is truncate posteriorly. On the left side its posterior dorsal angle extends caudad to a point a little beyond middle of aedeagus, but does not form the long slender hook as in *D. mutata* or *D. monroviana.*

Female genitalia. Anal flap approximately one third longer than wide, tapering posteriorly to a roundingly pointed apex. The eleventh segment small, showing very little, bearing a slender dorsal stylus. External valves of ovipositor broadest at a point midway of their length, their combined width greater than their length.

Notes on distribution. The type specimens are in Dr. E. D. Ball's collection, Tucson, Ariz. He collected twelve specimens from Tia Juana, Cal., and Tia Juana, Mexico. The writer had a long series of specimens to study collected from the following places in California: Alpine, Campo, San Diego county and Claremont county, by R. H. Beamer, in July and August.

Dictyssa transversa Van Duzee, 1914

Van Duzee, E. P. A Preliminary List of the Hemiptera of San Diego county, California. Trans. San Diego Soc. of Nat. Sci., 2, p. 41, 1914.

Comparative notes. This is the smallest species in the genus, with the following measurements: length from apex of head to tip of tegmina, 2.5 mm. to 2.75 mm.; length of tegmen, 2 mm. to 2.25 mm.; width of tegmen, 1.1 mm. to 1.25 mm. It is easily distinguished from other members of the genus by the whitish hyaline tegmina, reticulated with heavy brown nerves and crossed by two brownish fuscous bands, one located just anterior to apex of clavus and the other at base of apical fourth of the corium; the wing venation is characteristic; vein Sc is simple; vein R is not angled but broadly sinuate, extending nearer to vein M_{1+2} than Sc_2; veins M and Cu_1 both branched about the same distance from base at a point just anterior to middle; all veins rather straight and running more or less parallel.

Male genitalia. Anal flap (10th abdominal segment) long, slender with lateral margins parallel and posterior margin rather broadly concave, its length a little over twice its width. The eleventh segment inconspicuous and its dorsal stylus short and broad.

Harpagones (genital styli) visible externally as triangular plates, which are twice as broad at base as at their tips; the anal flap scarcely visible beyond their apices; each harpago is quadrangular with dorsal and ventral margins parallel, except for the posterior dorsal angle which is prolonged dorsad into a slender process which is slightly recurved at tip and at base of which is located a short, broad external hook.

The aedeagus is a curved tubular structure. On the right side it bears a small, sinuately curved, well-sclerotized spine attached at middle, and two sclerotized hooks or processes attached near base and which extend beyond theca for only part of their length. The dorsal one of these is almost straight and extends beyond theca only about one third as far as the other; the ventral one, curving to a sharp ventrad curving point, extends almost to middle of the aedeagus. On the left side the aedeagus bears a short projection attached at apex of its basal third. The theca on the right side envelopes the aedeagus for only about one fourth the length of the latter and is truncate posteriorly. On the left side its dorsal angle extends caudad as a sharply pointed, partially sclerotized projection for a distance equaling about two thirds the length of the aedeagus.

Female genitalia. Anal flap short, and in length about one fourth greater than wide. The eleventh segment is barely visible and possesses a long dorsal stylus. The external valves of the ovipositor have their greatest width at a point just posterior to the middle; the length of each valve is approximately one third greater than the width.

Notes on distribution. Mr. Van Duzee in the original description gives the following notations: "Described from numerous specimens mostly taken on the slopes of Mt. Soledad at La Jolla, from Sept. to Nov. Also taken at Alpine in Mar. and Oct. and at Torrey Pines in June. Like most of its congeners it lives on Artemisia." Dr. R. H. Beamer collected a small series of these at San Diego, Cal., in August, 1935.

Dictyssa quadravitrea, n. sp.

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen, 2.7 mm. Length of tegmen, 2.1 mm.; width of tegmen, 1.5 mm.

Color. General color of body yellowish-brown; tegmina also yellowish-brown with large hyaline cells through middle. Vertex, pronotum and mesonotum from above uniformly yellowish-brown.

Eyes dark brown. Disc of frons yellowish-brown; margins dark, outlined in brown. Postclypeus and genae likewise uniformly yellow-brown. Clavola of antennae dark brown. Thorax from under side slightly lighter than rest of body. Legs tan or yellow-brown as well as most of abdomen except for median margins of ovipositor valves, which are dark. Tegmina yellowish-brown except for the following variations: a dark spot at base; an oblique hyaline band, which starts on clavus at its middle, runs posteriorly to a point just beyond middle of corium, then bends ventrad and extends as a transverse band to the costal border; numerous ovate whitish hyaline spots in the apical and expanded costal borders.

Structural characteristics. Vertex somewhat produced cephalad beyond eyes, its anterior margin quite straight, its lateral margins slightly converging anteriorly, the length at this point equal to length of pronotum at middle. Greatest width of eyes approximately one third of the width of the vertex. Pronotum with anterior margin roundingly produced and its posterior margin shallowly concave; its length through middle approximately two thirds of the length of the mesonotum; the disc somewhat depressed, in each half of which just laterad of median line is a faint round depression. Mesonotum with a faint median carina present, laterad of which on either side the disc is somewhat depressed; a faint transverse groove across base of apical projection. Frons slightly wedge-shaped, being broader at its extreme posterior end due to lateral margins converging slightly anteriorly; lateral margins considerably elevated; length and width subequal. Postclypeus dovetailed into frons a short distance only. A distinct median carina present on both frons and clypeus. Tegmina narrowed greatly at base where their width is only about one third of their width at apex; their greatest width beyond apex of clavus at a point which is at base of apical third; the costal border narrowly expanded; the cells large, very angular, many of them rectangular or hexagonal in shape, which together with the hyaline texture gives a characteristic look to the wing of resembling panes of glass in a window. Venation of the tegmen as follows: vein R mostly sinuate with a slight angle located just posterior to middle, at which point vein R is equidistant from Sc_2 and M_{1+2}; vein M_{1+2} straight, running lengthwise at about median line of tegmen; vein M_{3+4} simple, but making a bend dorsad to meet Cu_{1a}.

Female genitalia. Anal flap (10th abdominal segment) two thirds as wide as long, its lateral margins parallel for two thirds of the length, from whence they taper to a rounded apex. The eleventh

segment only slightly visible and bearing a short dorsal stylus. External valves of ovipositor with their length one third greater than their width and their greatest width through middle.

Comparative notes. This species was described from only one female specimen but, since it was distinctly different from any other species in the genus or even in the subfamily, it seemed advisable to describe it even though lacking a series of specimens. The following structures are the most distinguishing characters: the somewhat anteriorly produced vertex, the wedge-shaped frons, the extreme narrowness at base of the tegmen, and the presence in the tegmen of extremely large angular cells and the broad oblique band of hyaline cells across the corium.

Location of types. The holotype female is in the National Museum at Washington, D. C. The labels on the specimen state that it is from the P. R. Uhler collection and was taken in Placer county, California, in October.

Dictyssa beameri, n. sp.

ORIGINAL DESCRIPTION

Size. Length of body from tip of head to apex of tegmina, 2.38 mm. to 2.75 mm. Length of tegmen, 1.875 mm. to 2.13 mm.; width of tegmen, 1.395 mm. to 1.5 mm. This is one of the smallest species in the genus.

Color. General color dark brown variegated with yellow on body and many whitish hyaline cells on tegmina. Vertex brown except for a yellow median line and a spot at each lateroposterior corner. Pronotum brown except for a narrow median line, a large spot occupying each lateral half of disc and all the margins yellow. Mesonotum dark brown through central half, each lateral fourth light yellow with a brownish spot in center and all margins light. Frons brown except for pale yellow on median carina, a narrow border inside brown outer margins and an irregular longitudinal streak down middle of each lateral half which converges with the one from opposite side below the abbreviated median carina. Postclypeus brown except for anterior border and median carina, which are somewhat lighter. Gena above and around antenna brown; just below a broad pale band. Underside of thorax pale yellow. Abdomen of male pitch brown. Abdomen of female yellowish-brown; genital appendages dark brown. Legs dark brown. Tegmina pitch brown with small whitish hyaline areas in the following places: on clavus in the center of each small cell; on corium, four elongate cells follow-

ing the claval suture and a cluster of cells just caudad of claval apex; an oblique band of many cells starting at a point midway of clavus and extending across corium to a point on costal border at about base of apical third of tegmen; in apical border small, round, uniform spots, numbering six or seven; costal border with spots between the brownish veinlets and two clusters of small cells just mesad of costal vein.

Structural characteristics. Vertex very broad and short, its lateral margins elevated and slightly converging anteriorly, somewhat depressed across disc. Greatest width of eye less than half the width of the vertex. Pronotum with anterior margin rounding and considerably produced forward; its length through middle about twice that of vertex at middle; a median carina only faintly discernible; two small, depressed, round spots on disc, one on each side of median line. Mesonotum with its anterior margin roundingly produced; in length twice as long as pronotum at middle; a distinct median carina present and a transverse groove just posterior to anterior margin but not reaching to the sides; a transverse groove at base of apical prolongation; shallow depression in center of each lateral half. Tegmina broadest at a point in line with apex of clavus, the apical margin evenly rounding, the costal border moderately expanded; veins prominent, cells small; veins M and Cu_1 branching at a point just anterior to apex of clavus, vein M_{1+2} running through center of tegmen and branching at base of apical third, vein R with no acute angle, broadly sinuate, almost equidistant from veins M_1 and Sc_2.

Male genitalia. Anal flap (10th abdominal segment) shorter than in most species, its width about three fifths of its length; its lateral margins slightly concave through middle; its posterior margin distinctly notched at middle. The eleventh segment only slightly visible externally and bearing a short dorsal stylus.

Harpagones (genital styli) visible externally as two triangular plates, which are broad at base but taper to slender apices beyond which is visible a small portion of the anal tube. Each harpago as viewed from a flattened lateral position (see drawing 16, plate XLI) is roughly rectangular, broadest through apical third, with the ventral margin outwardly curved and the dorsal posterior angle prolonged dorsad into a flat hook with a recurved, pointed apex. At the base of the dorsal projection is a ventrad curving flat external hook.

The aedeagus as viewed from the right side is a short tubular structure bearing a flat, pointed projection attached at middle and extending caudad to base of apical fourth. Another well-sclerotized

hook attached to base of aedeagus, whose apex only shows beyond theca as a dorsad-curving stout hook. On the left side the aedeagus is practically covered by the membranous theca, which is prolonged caudad more than in most species as a flat plate. On the right side the theca covers the aedeagus for only the basal third of the latter and has its posterior margin truncate.

Comparative notes. This little species is readily distinguished from other species by the following characters: the tegmina are reticulated into many small cells, of which many are whitish hyaline and contrast strongly with the deep fuscous or dark-brown coloration of the rest of the wing; in fact, the pattern of the wing is very similar to that of the genus *Dictyobia;* the wing venation is distinctive in that the veins all run more lengthwise of the wing; vein R is not angled but only broadly sinuate, and therefore equidistant from veins Sc_2 and M_1 and vein M_{1+2} divides before apex, which it does not do in any other species. The male genitalia is quite distinct from those of other species (see drawings 7a and 7b, plate XXXIX).

Location of types. This species was described from a holotype male, collected at Carson City, Nev., August 9, 1929, and an allotype female, same date, by R. H. Beamer. These types are in the Francis Huntington Snow Entomological Collection at the University of Kansas.

Dictyssa balli, n. sp.

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen, 3 mm. to 3.1 mm.; length of tegmen, 2.25 mm. to 3 mm.; width of tegmen, 1.5 mm. to 1.6 mm.

Color. General body color fulvous, washed in brown. Vertex dark brown with a faint yellow median line. Pronotum and mesonotum brown with a broadish white median line. Frons and clypeus uniform brown. Under side of thorax and abdomen yellow. Legs yellow with brown-tipped spines. Tegmina uniformly pitch brown with a greatly contrasting band of whitish hyaline cells extending lengthwise across corium from base of clavus to a point somewhat anterior to apical margin of corium; the entire apical margin studded by pellucid disclike or semicircular spots which are practically all of equal size.

Structural characteristics. Vertex broad and short, its lateral margins tapering anteriorly, its length through middle about one half the length of the pronotum. Greatest width of eyes about one

half the width of the vertex at its anterior margin. Pronotum with its anterior margin rounding and its posterior margin very shallowly emarginate; two small depressed, round spots on disc; its length through middle one half the length of the mesonotum at middle. Mesonotum with a transverse crease following posterior border of pronotum but not reaching to lateral margins; a faint median carina present; a shallow depression in disc on each side of median line and a transverse groove at base of apical prolongation. Frons with lateral margins outwardly bulging; length and width subequal; median carina distinct, not quite reaching clypeus. Postclypeus moderately inflated, dove-tailed into frons to a point about one fourth of the greatest length of the latter. Tegmina differing greatly from other members of the genus by their slenderness; each tegmen in length two fifths longer than wide, its greatest width at a point in line with apex of clavus; the apical margin sloping gently from apex of clavus, thence evenly rounding to the costal border; the costal border moderately expanded and crossed by numerous dark-brown veinlets; an oblique hyaline band present, made up of a spot on base of clavus and four cells on corium, the largest one of which is an elongate central cell between veins R and M and which is approximately twice as long as wide and has its border studded by 8 to 9 spurs of veins; the second largest cell lying posterior to this, usually angular in shape and about one fourth or one third of the size of the central cell; veins Sc and R running parallel and very close together for about two thirds of the length of the tegmen, at which point vein R makes a distinct bend toward vein M_{1+2}, which makes it in this region nearer to the latter vein than to vein Sc_2; M_{1+2} simple; vein Cu_1 branching somewhat more anteriorly than M.

Male genitalia. Anal flap (10th abdominal segment) narrow at extreme base, then broadening through basal third, from whence it narrows to a truncate apex; its length twice its width; a short dorsal stylus of the eleventh segment present, but none of the latter showing externally.

Harpagones (genital styli) visible externally as broad, triangular, flat plates whose apices are sharply pointed; the anal flap not visible to any extent beyond their apices. From a flattened lateral view (see drawing 24, plate XLI) each process is characteristically subquadrangular, broadest through apical third and with its posterior

dorsal corner prolonged dorsad into a short, pointed, slightly recurved process, at base of which is a short, broad, recurved external hook.

The aedeagus is a curved tubular structure. On the right side it bears a long, flat, sharply pointed projection attached midway of its length and extending posteriorly to about the base of the apical sixth of the aedeagus; also two hooks attached near base which are covered by the theca at their bases, the dorsal one extending beyond the theca about twice as far as the other, with its extereme apex curved ventrad and sharply pointed, the ventral one almost straight and bluntly pointed. On the left side the aedeagus bears also a flat, pointed projection which is attached somewhat posterior to the middle and extends almost to apex of the aedeagus. No additional basal hooks are found on this side. The theca on the right side covers the aedeagus at base for about one third the length of the latter; its posterior margin is shallowly concave. On the left side the theca is about the same as on the right side, except that its dorsal posterior angle is extended posteriorly as far as the middle as a slender, sharply pointed projection which resembles an aedeagal hook and its posterior margin seems to be divided at middle.

Female genitalia. Anal flap about one third longer than wide, sharply tapering to a blunt, narrowed apex. The eleventh segment scarcely visible, its dorsal stylus moderately long. The external valves of the ovipositor broadest through middle, in length about one third longer than wide.

Comparative notes. This species is easily recognizable by its elongate form. Dr. E. D. Ball, recognizing this species as new, was preparing to call this species *elongata,* but when the writer started revising this genus he very graciously relinquished any prior claim to it and told the writer to describe it. For this generosity and magnaminity of spirit the writer preferred to name the species in his honor, although *elongata* would have been a very descriptive name. It is much the longest and narrowest species in the genus. It can be recognized furthermore by the fact that the hyaline band on tegmen runs more nearly lengthwise than in other species, is abbreviated before reaching apex and has the central clear cell about twice as long as wide. For further comparative notes see the discussion under this heading in the description of *mutata.* The male genitalia are distinctive.

Notes on distribution. A long series of this species was taken by R. H. Beamer in August at Campo, Cal.

Location of types. In the Francis Huntington Snow Entomological Collection at the University of Kansas. Holotype, allotype, and paratypes from Campo, Cal., August 10, 1935, collected by R. H. Beamer.

Dictyssa monroviana, n. sp.

ORIGINAL DESCRIPTION

Size. Length of body from tip of head to tip of tegmen, 2.4 mm. to 2.9 mm. Length of tegmen, 2 mm. to 2.3 mm.; width of tegmen, 1.5 mm. to 1.6 mm.

Color. A fuscous brown species marked with hyaline on the tegmina. Vertex uniformly yellowish-brown with a faint median yellow line. Pronotum and mesonotum, uniformly yellowish or fuscous brown. Frons and clypeus uniformly brown. Underside of thorax and legs yellowish-brown. Abdomen dark brown. Tegmina with the oblique hyaline band very conspicuous and proportionally long; large, round or hemispherical whitish hyaline cells, alternating with small ones across apical margin and a cluster of three to four small hyaline cells just beyond apex of clavus in cells Cu_{1a} and Cu_{1b}; rest of wings dark fuscous with veins frequently lighter in color.

Structural characteristics. Vertex slightly narrowed anteriorly, depressed through middle, its length through middle about one half the length of the pronotum. Greatest width of eye less than one half the width of vertex. Pronotum with all its margins elevated, usually no median carina present; two small faint depressed spots on disc. Mesonotum with median carina lacking or at most only faintly indicated; a transverse groove following anterior margin, but stopping either side before reaching lateral margins; length through middle twice that of pronotum. Frons with lateral margins parallel, considerably elevated; median carina distinct, but abbreviated before reaching apex; a broad depression on each side between lateral margin and median carina. Postclypeus with posterior margin angularly produced into the frons for a distance equal to about one third the length of the latter. Tegmina about one fourth longer than wide, broadest through base of apical fourth; its posterior margin truncately rounding, the costal margin broadly expanded; cells large with the hyaline area large in proportion to the opaque regions, the oblique hyaline band starting on clavus where it is very broad and

continuing across corium as about five very large angular cells, the largest one being on the disc between veins R and M and which is elongate oval in shape, in size at least twice as long as wide, and with its margins studded by 9 to 10 spurs of veins; two other large cells ventrad to this, the one on coastal border especially so; typically four to five large round or oval cells present on apical border, with smaller ones in between; vein R at apex of central hyaline cell making an acute angle which is at a point nearer to vein M_{1+2} than Sc_2 and as in *mutata* more posterior in the wing, usually at base of apical fourth; vein M_{1+2} simple.

Male genitalia. Anal flap (10th abdominal segment) about twice as long as wide and with an evenly rounding apex. Eleventh segment scarcely visible, its dorsal stylus very long and slender, reaching almost to apex of the flap.

Harpagones (genital styli) visible externally as triangular plates, broad at base and with tapering apices. Each harpago, from a flattened lateral view (see drawing 23, plate XLI), is rectangular in outline and has its posterior, dorsal corner prolonged dorsad into a slenderly pointed projection at the base of which is a slender, recurved, external hook.

The aedeagus is a curved, tubular structure, shorter than in many species. On the right side it bears a flat, sharply pointed process, attached at base of apical third and extending almost to apex. Attached to its base are two well-sclerotized hooks which are covered at their bases by the theca but extend beyond it, the ventral one to a point beyond middle of aedeagus and the dorsal one somewhat anterior to it. The ventral hook is more slender and has its pointed apex curved ventrad. The dorsal hook is blunt and nearly straight. On the left side the aedeagus bears no basal hooks. There is present a flattened, sharply pointed projection attached at base of apical third which almost reaches the apex. The theca on the right side covers slightly over one third of the aedeagus at base and has the posterior margin somewhat triangularly produced caudad. On the left side the theca also covers the basal third of the aedeagus, but has its dorsal angle prolonged caudad as a long, sharply pointed flap which in typical forms reaches almost to apex of the aedeagus.

Comparative notes. This species is recognized by the large hyaline cells and spots of the tegmina, especially that of the very large central cell, which is at least twice as long as broad. It more nearly resembles *D. mutata* and *D. obliqua* in size and shape. It resembles *D. obliqua* by having the head and thorax fuscous or darkish, but it

differs from it by having the angle of vein R located more posteriorly, approximately at base of apical fourth. It differs externally from *D. mutata* by having the head and thorax darkish or washed with fuscous, while in the latter the head is bright yellow; also, because vein R in *monroviana* approaches nearer to vein M_{1+2} than vein Sc. The aedeagus is more similar to *D. mutata* than that of any other species. Typical examples of the two species show the following differences: in *D. monroviana* the thecal hook is longer and is always visible, extending to middle at least and in some cases almost to tip of aedeagus, while in *D. mutata* the thecal hook is transparent, not readily distinguishable and does not extend beyond middle; as a general rule the dorsal aedeagul hook is proportionally smaller in *D. mutata* than in *D. monroviana.* Many gradating forms of the aedeagus between these two have been found, however, but all dark-headed specimens with the large hyaline cells have been placed under *monroviana.* For further discussion see notes under this heading in the description of *mutata.*

Location of types. Holotype male, allotype female and eleven paratypes, Monrovia, Cal., August 27, 1935, collected by R. H. Beamer, in the Snow Entomological Collection at the University of Kansas. In the same collection other paratypes from Laguna Beach, August 25, 1933, from Claremont, Cal., Aug. 29, 1935, and a long series from Orange county, California, collected by R. H. Beamer in August, 1929, and two paratypes from San Jacinto mountains, California, collected by L. D. Anderson and R. H. Beamer in August, 1929.

Dictyssa maculosa, n. sp.

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen, 2.5 mm. Length of tegmen, 2.13 mm.; width of tegmen, 1.38 mm.

Color. General color similar to *D. mutata* in that both species have dark-brown tegmina with bright-yellow heads and pronota. Vertex bright yellow with margins etched in dark brown. Eyes reddish-brown. Pronotum uniformly bright yellow except darker at extreme lateral margins. Mesonotum bright yellow except fuscous at lateral corners and in the depressed area either side of the median carina. Front uniformly yellow in the type female with margins faintly etched in dark brown; in the paratype female a group of dark spots speckled along lateral margins. Postclypeus bright yellow with traces of reddish or brownish oblique stripes on each side. Gena and rest of head bright yellow except pedicel of antenna, which

is fuscous. Underside of thorax bright yellow. Legs bright yellow with carinae of femora and tibiae and tips of tarsi and tarsal claws fuscous. Abdominal segments mostly yellow, a little darker at sides. External valves of ovipositor brown with their median margins much darker. Tegmina blackish-brown and very opaque except for the numerous whitish hyaline spots which in the main occur in the following regions: an oblique band starting on clavus where it occupies the basal third, then extends across corium to just beyond middle, at which point it joins a transverse band of hyaline cells, about equal in size and which extends from a point just posterior to apex of clavus across to the costal border; between the larger transverse band and the apical margin a second but more abbreviated transverse band made up of four ovate spots, the apical margin studded with ovate or round spots, the larger ones, of which there are four, alternating with either one or two small ones; the costal border with numerous white spots between the dark margined veinlets; a group of three to four uniformly ovate spots in the cells between veins R and Sc.

Structural characteristics. Vertex not greatly produced beyond the eyes; its anterior margin almost straight; its lateral margins distinctly converging anteriorly; all margins greatly elevated; length through middle a little over one half the length of pronotum at middle; a very shallow round depression in the mesoposterior corner of each lateral fourth. Greatest width of eyes one third the width of the vertex. Pronotum with anterior margin strongly roundingly emarginate; posterior margin shallowly concave; all margins greatly elevated; a median carina only faintly indicated, laterad of which on each side in the disc is a faint round depressed spot. Mesonotum triangular; the disc depressed; a transverse ridge across middle half, running parallel with anterior margin; a median carina present and a faint groove indicated across base of apical extension; length about twice that of pronotum. Frons with anterior margin almost straight and lateral margins slightly bulging outwardly, all margins considerably elevated; a distinct median carina present on posterior two thirds but completely gone from apex. Postclypeus dovetailed into frons for not more than one sixth of the length of the latter and moderately inflated. Tegmina with apical and costal margins rounding, the latter expanded somewhat but not greatly reflexed; greatest width of tegmen near base of apical fourth; the largest cells of wing found in the oblique hyaline band, consisting of one large elongate cell about one third to one half longer than wide, whose margins are studded with triangular dark-brown spurs of veins num-

bering about eight to nine and whose apex reaches not far beyond middle of the wing; a second large hyaline cell somewhat anterior to the central cell, which is angular in shape, and a third bilobed and somewhat smaller posterior cell which extends into the transverse row of small, ovate hyaline cells. Wing venation as follows: veins Sc and R united for only a short distance from base of wing, vein R broadly sinuate with a slight angle indicated at apex of the central hyaline cell, at which point R is equidistant from veins Sc_2 and M_{1+2}; vein M_{1+2} makes the characteristic bend towards the costal border; vein M_{3+4}, separated at base of apical third or else the tip of Cu_{1a}, which seems to be lost in the apical network, has secondarily united to the stem of M_{3+4}, thus giving that vein a two-branched appearance.

Female genitalia. Anal flap (10th abdominal segment) broad at base, tapering to a bluntly rounding apex; in length one-third longer than wide. The eleventh abdominal segment inconspicuous, but bearing a slender, tubular dorsal stylus. The external valves of the ovipositor conspicuous, their length not quite twice the width, their greatest width at middle.

Comparative notes. This species is easily separated from other species in the genus by the bright-yellow head and thorax, which contrasts greatly with heavy pitch-brown tegmina, by the large number of ovate or round whitish hyaline cells which are present not only as an oblique band across corium but are arranged in two transverse rows through apical third of tegmen and also in apical region between the costal vein and vein R.

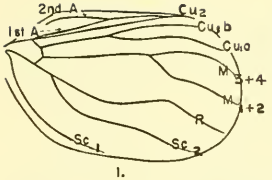
Location of types. Holotype female, collected at Anza, Cal., Aug. 6, 1935, by R. H. Beamer, and one paratype female, collected at Idyllwild, Cal., Aug. 8, 1935, by R. H. Beamer, in the Francis Huntington Snow Entomological Collection at the University of Kansas.

PLATE XXXVI

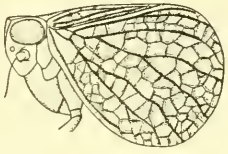
FIGURE

1. Diagram of a tegmen.
2. Lateral view of *Dictyssa fusca.*
3. Lateral view of *Dictyssa clathrata.*
4. Lateral view of *Dictyssa monroviana.*
5. Lateral view of *Dictyssa ovata.*
6. Lateral view of *Dictyssa maculosa.*
7. Lateral view of *Dictyssa obliqua.*
8. Lateral view of *Dictyssa marginepunctata.*
9. Lateral view of *Dictyssa beameri.*
10. Lateral view of *Dictyssa quadravitrea.*
11. Lateral view of *Dictyssa fenestrata.*
12. Lateral view of *Dictyssa mutata.*
13. Lateral view of *Dictyssa transversa.*
14. Lateral view of *Dictyssa balli.*
15. Lateral view of *Dictyssa areolata*—type specimen.
16. Lateral view of *Dictyssa arcolata*—perfect specimen.

PLATE XXXVI



1.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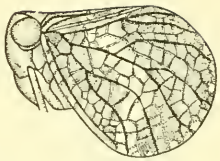
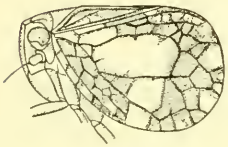

3 D.clathrata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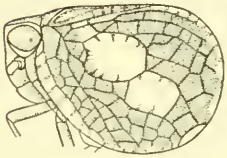
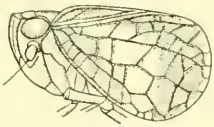

5. D.ovata

6. D.maculosa

7. D. obliqua

8. D.marginepunctata

9. D.beameri

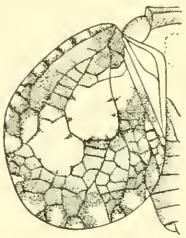

10. D.quadravitrea

11. D.fenestrata

12. D.mutata

13. D transversa

14. D.balli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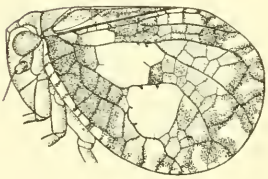

16. D.arealata

PLATE XXXVII

FIGURE

1. Dorsal view of head and thorax of *Dictyssa clathrata.*
2. Dorsal view of head and thorax of *Dictyssa fusca.*
3. Dorsal view of head and thorax of *Dictyssa ovata.*
4. Dorsal view of head and thorax of *Dictyssa transversa.*
5. Dorsal view of head and thorax of *Dictyssa mutata.*
6. Dorsal view of head and thorax of *Dictyssa obliqua.*
7. Dorsal view of head and thorax of *Dictyssa areolata.*
8. Dorsal view of head and thorax of *Dictyssa beameri.*
9. Dorsal view of head and thorax of *Dictyssa marginepunctata.*
10. Dorsal view of head and thorax of *Dictyssa maculosa.*
11. Dorsal view of head and thorax of *Dictyssa balli.*
12. Dorsal view of head and thorax of *Dictyssa quadravitrea.*
13. Dorsal view of head and thorax of *Dictyssa fenestrata.*
14. Dorsal view of head and thorax of *Dictyssa monroviana.*
15. Cephalo-ventral aspect of head of *Dictyssa clathrata.*
16. Cephalo-ventral aspect of head of *Dictyssa fusca.*
17. Cephalo-ventral aspect of head of *Dictyssa areolata.*
18. Cephalo-ventral aspect of head of *Dictyssa balli.*
19. Cephalo-ventral aspect of head of *Dictyssa transversa.*
20. Cephalo-ventral aspect of head of *Dictyssa monroviana.*
21. Cephalo-ventral aspect of head of *Dictyssa fenestrata.*
22. Cephalo-ventral aspect of head of *Dictyssa maculosa.*
23. Cephalo-ventral aspect of head of *Dictyssa quadravitrea.*
24. Cephalo-ventral aspect of head of *Dictyssa ovata.*
25. Cephalo-ventral aspect of head of *Dictyssa beameri.*
26. Cephalo-ventral aspect of head of *Dictyssa mutata.*
27. Cephalo-ventral aspect of head of *Dictyssa obliqua.*
28. Cephalo-ventral aspect of head of *Dictyssa marginepunctata.*

PLATE XXXVII

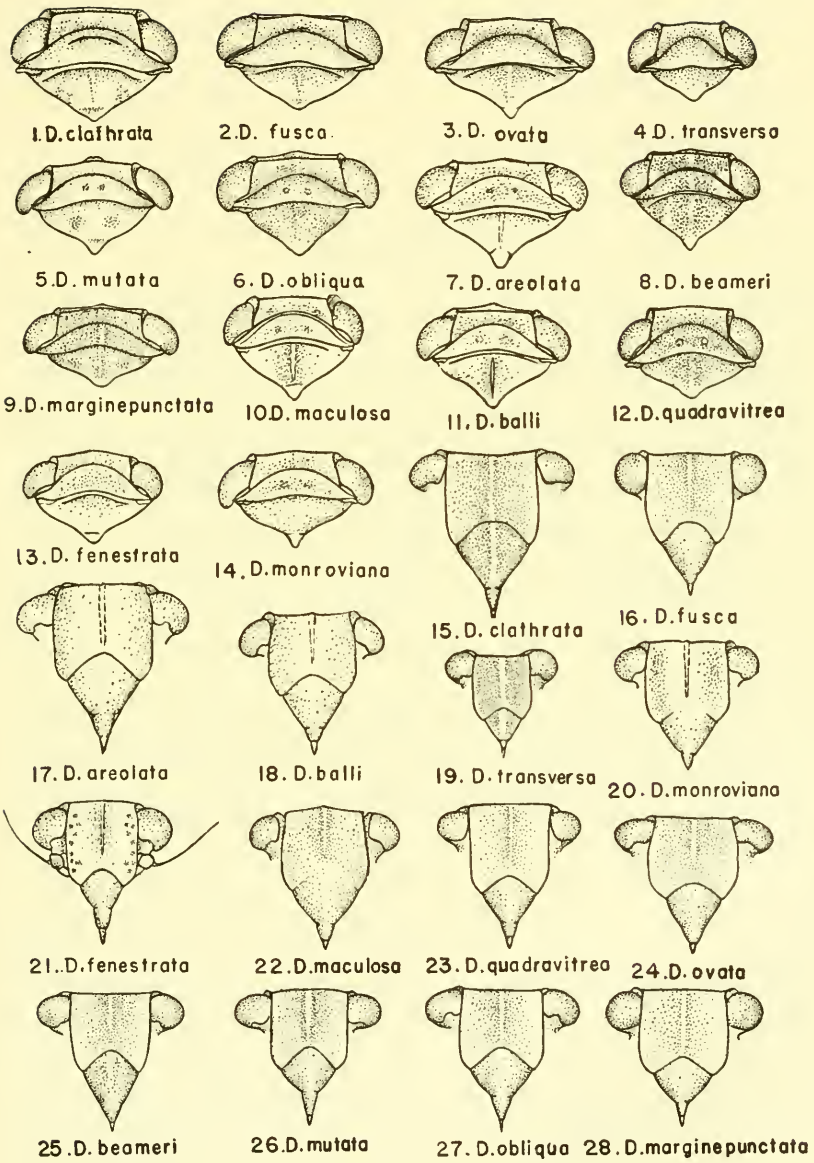


PLATE XXXVIII

FIGURE

1a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa clathrata.*

1b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa clathrata.*

2a. Lateral aspect as viewed from right side of male genitalia of *Dictyssa fusca.*

2b. Lateral aspect as viewed from left side of male genitalia of *Dictyssa fusca.*

3a. Lateral aspect as viewed from right side of male genitalia of *Dictyssa ovata.*

3b. Lateral aspect as viewed from left side of male genitalia of *Dictyssa ovata.*

4a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa areolata.*

4b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa areolata.*

5a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa balli.*

5b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa balli.*

PLATE XXXVIII

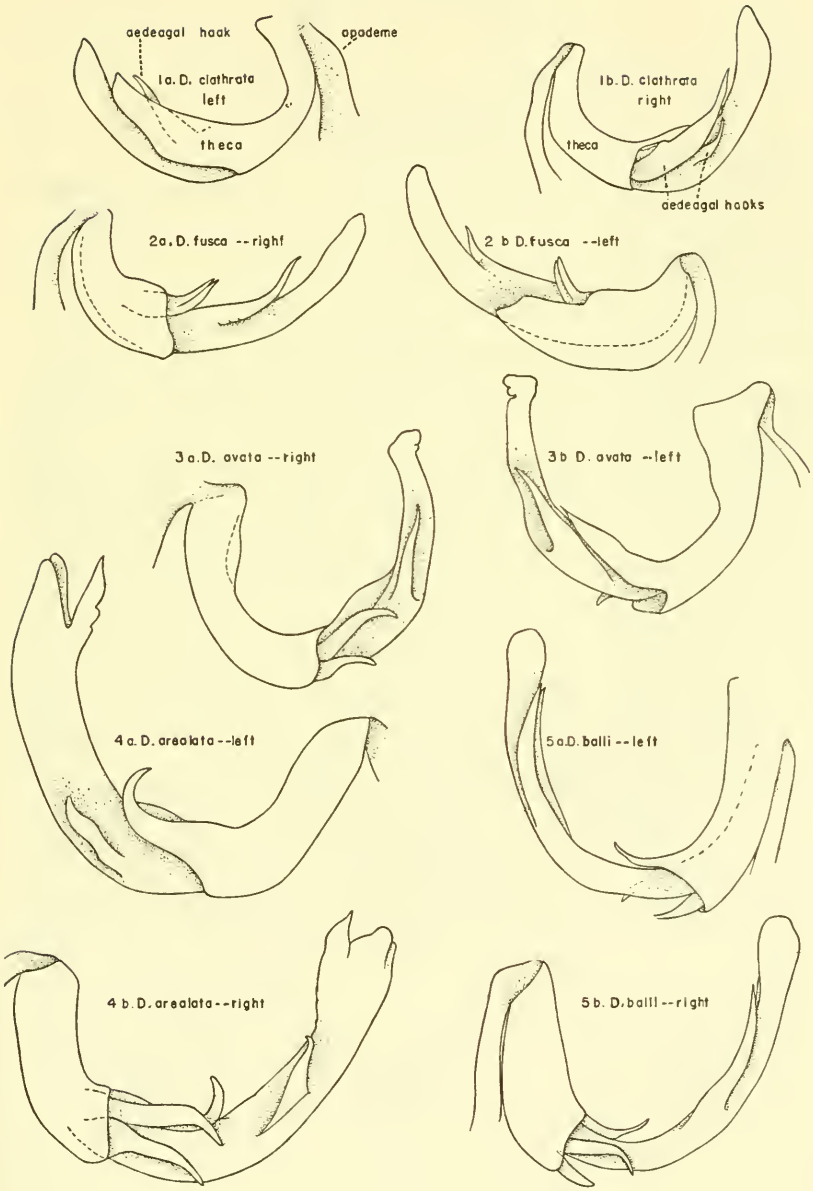


PLATE XXXIX

FIGURE

6a. Lateral aspect as viewed from right side of male genitalia of *Dictyssa fenestrata.*

6b. Lateral aspect as viewed from left side of male genitalia of *Dictyssa fenestrata.*

7a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa beameri.*

7b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa beameri.*

8a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa transversa.*

8b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa transversa.*

9a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa obliqua.*

9b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa obliqua.*

10a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa monroviana.*

10b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa monroviana.*

11a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa marginepunctata.*

11b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa marginepunctata.*

12a. Lateral aspect as viewed from left side of male genitalia of *Dictyssa mutata.*

12b. Lateral aspect as viewed from right side of male genitalia of *Dictyssa mutata.*

PLATE XXXIX

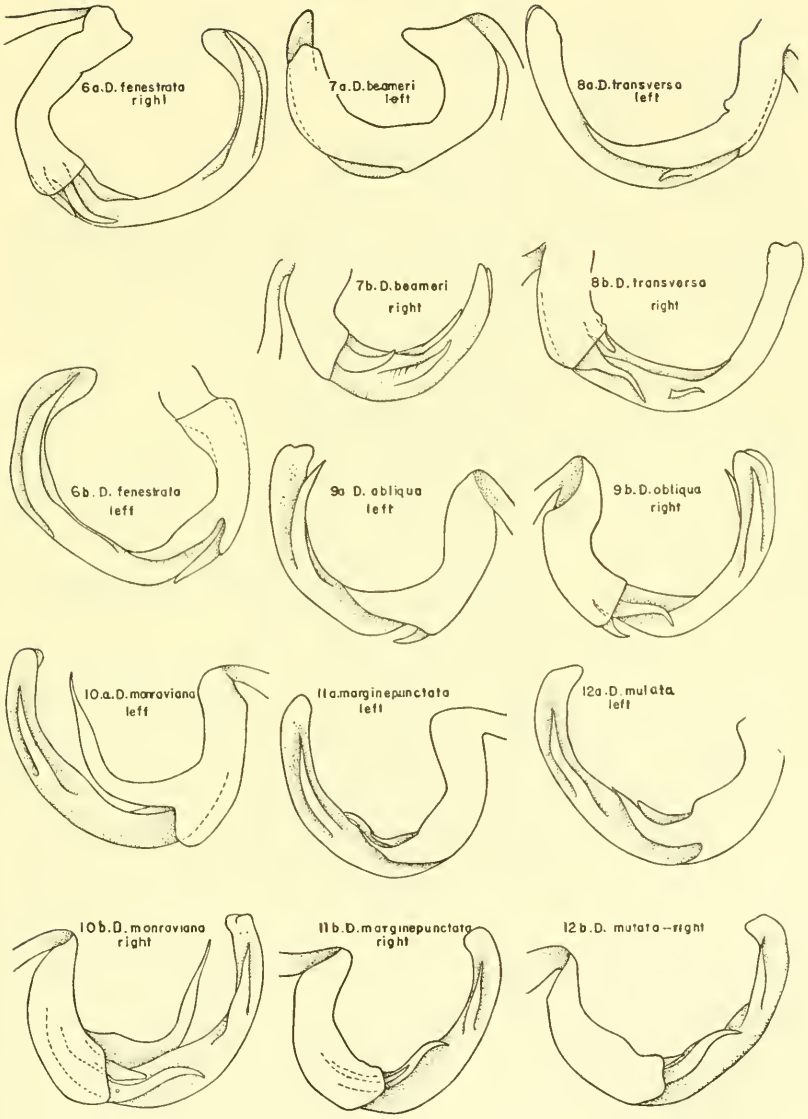

6a. D. fenestrata
right
7a. D. beameri
left
8a. D. transversa
left
7b. D. beameri
right
8b. D. transversa
right
6b. D. fenestrata
left
9a D. obliqua
left
9b. D. obliqua
right
10a. D. monroviana
left
11a. marginepunctata
left
12a. D. mutata
left
10b. D. monroviana
right
11b. D. marginepunctata
right
12b. D. mutata — right

PLATE XL

FIGURE

1. Dorsal aspect of the tenth abdominal segment (anal flap) of the male of *Dictyssa ovata.*
2. Same for *Dictyssa transversa.*
3. Same for *Dictyssa monroviana.*
4. Same for *Dictyssa balli.*
5. Same for *Dictyssa beameri.*
6. Same for *Dictyssa fusca.*
7. Same for *Dictyssa clathrata.*
8. Same for *Dictyssa obliqua.*
9. Same for *Dictyssa mutata.*
10. Same for *Dictyssa fenestrata.*
11. Same for *Dictyssa areolata.*
12. Same for *Dictyssa marginepunctata.*
13. Ventral aspect of the tip of the abdomen of the male of *Dictyssa beameri.*
14. Same for *Dictyssa transversa.*
15. Same for *Dictyssa balli.*
16. Same for *Dictyssa marginepunctata.*
17. Same for *Dictyssa monroviana.*
18. Same for *Dictyssa fenestrata.*
19. Same for *Dictyssa obliqua.*
20. Same for *Dictyssa clathrata.*
21. Same for *Dictyssa ovata.*
22. Same for *Dictyssa mutata.*
23. Same for *Dictyssa fusca.*

PLATE XL

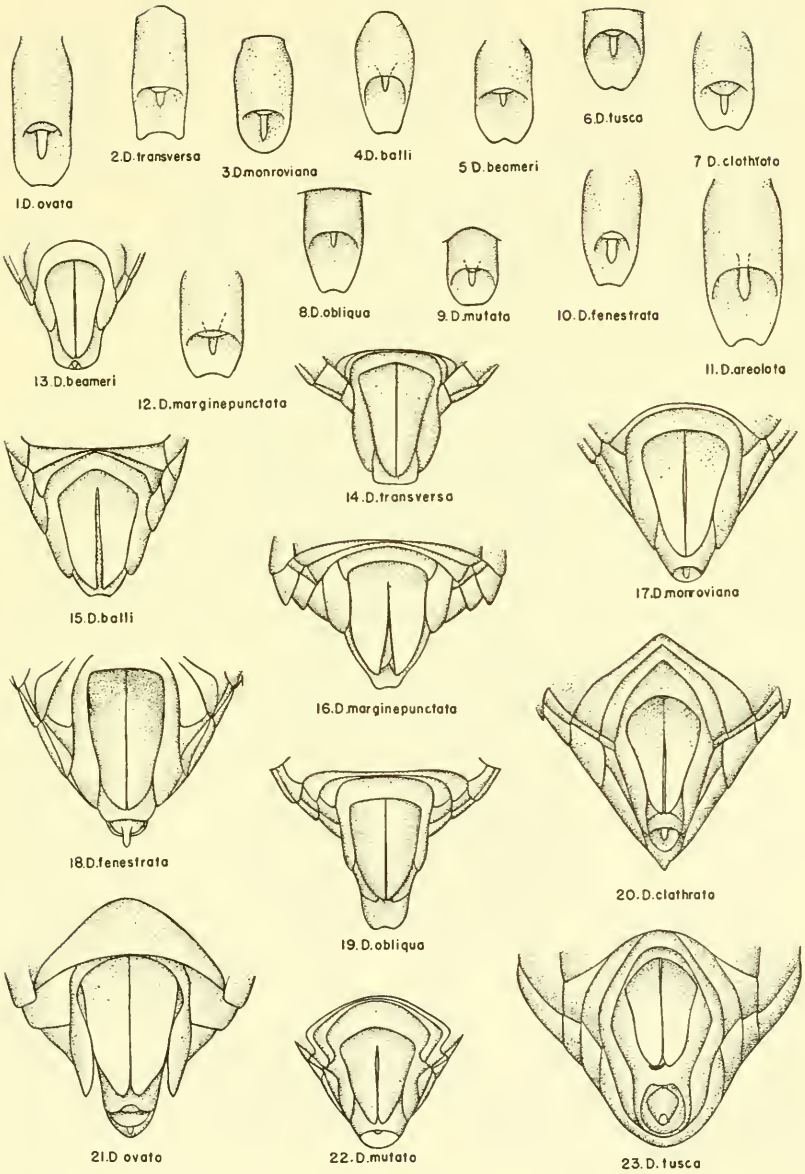

1.D. ovata
2.D. transversa
3.D.monroviana
4.D. batli
5 D. beameri
6.D.fusca
7 D. clathrata
8.D.obliqua
9.D.mutata
10. D.fenestrata
11. D.areolata
12. D.marginepunctata
13.D.beameri
14 .D.transversa
15.D.batli
16.D.marginepunctata
17.D.monroviana
18.D.fenestrata
19.D.obliqua
20.D.clathrata
21.D ovata
22.D.mutata
23.D. fusca

PLATE XLI

FIGURE

1. Dorsal aspect of the tenth abdominal segment of the female of *Dictyssa ovata.*
2. Same for *Dictyssa transversa.*
3. Same for *Dictyssa marginepunctata.*
4. Same for *Dictyssa monroviana.*
5. Same for *Dictyssa mutata.*
6. Same for *Dictyssa obliqua.*
7. Same for *Dictyssa fusca.*
8. Same for *Dictyssa clathrata.*
9. Same for *Dictyssa fenestrata.*
10. Same for *Dictyssa balli.*
11. Same for *Dictyssa areolata.*
12. Same for *Dictyssa quadravitrea.*
13. Same for *Dictyssa maculosa.*
14. Same for *Dictyssa beameri.*
15. Lateral aspect of harpago (male genital stylus) of *Dictyssa fenestrata.*
16. Same for *Dictyssa beameri.*
17. Same for *Dictyssa ovata.*
18. Same for *Dictyssa transversa.*
19. Same for *Dictyssa marginepunctata.*
20. Same for *Dictyssa clathrata.*
21. Same for *Dictyssa fusca.*
22. Same for *Dictyssa mutata.*
23. Same for *Dictyssa monroviana.*
24. Same for *Dictyssa balli.*
25. Same for *Dictyssa areolata.*
26. Same for *Dictyssa obliqua.*

PLATE XLI

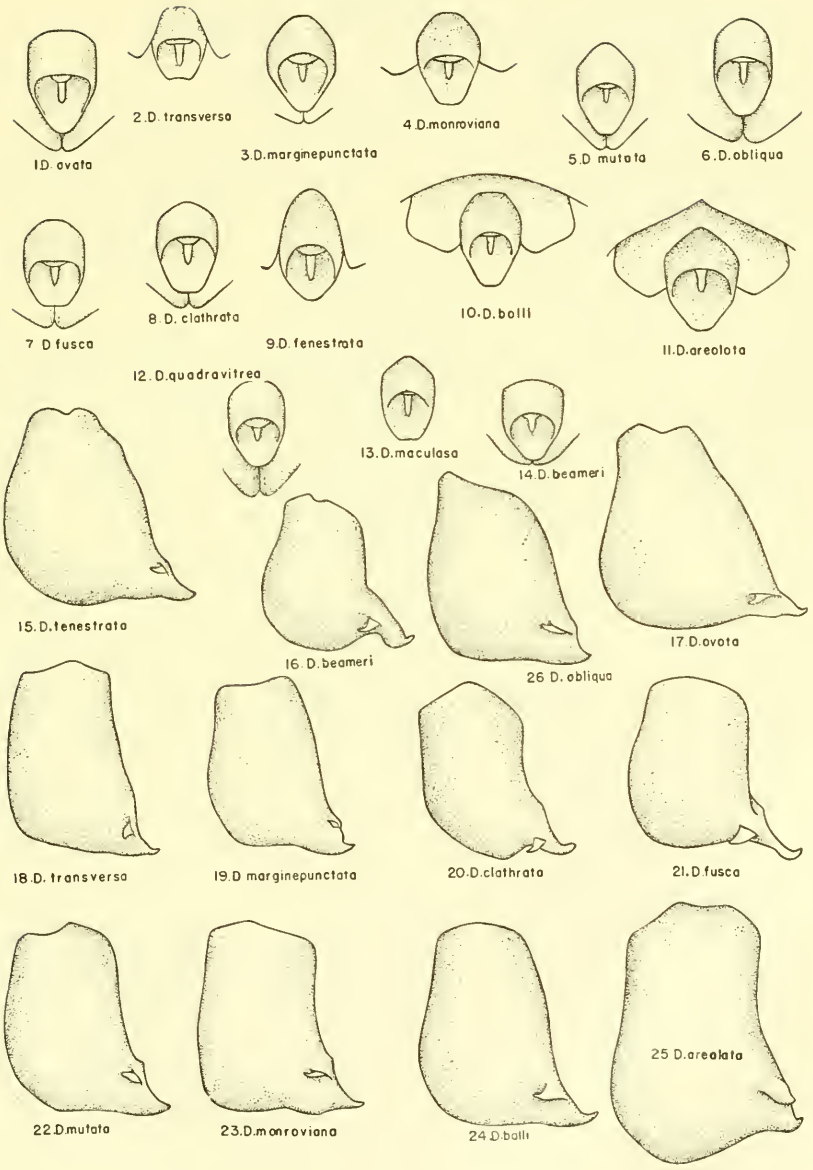
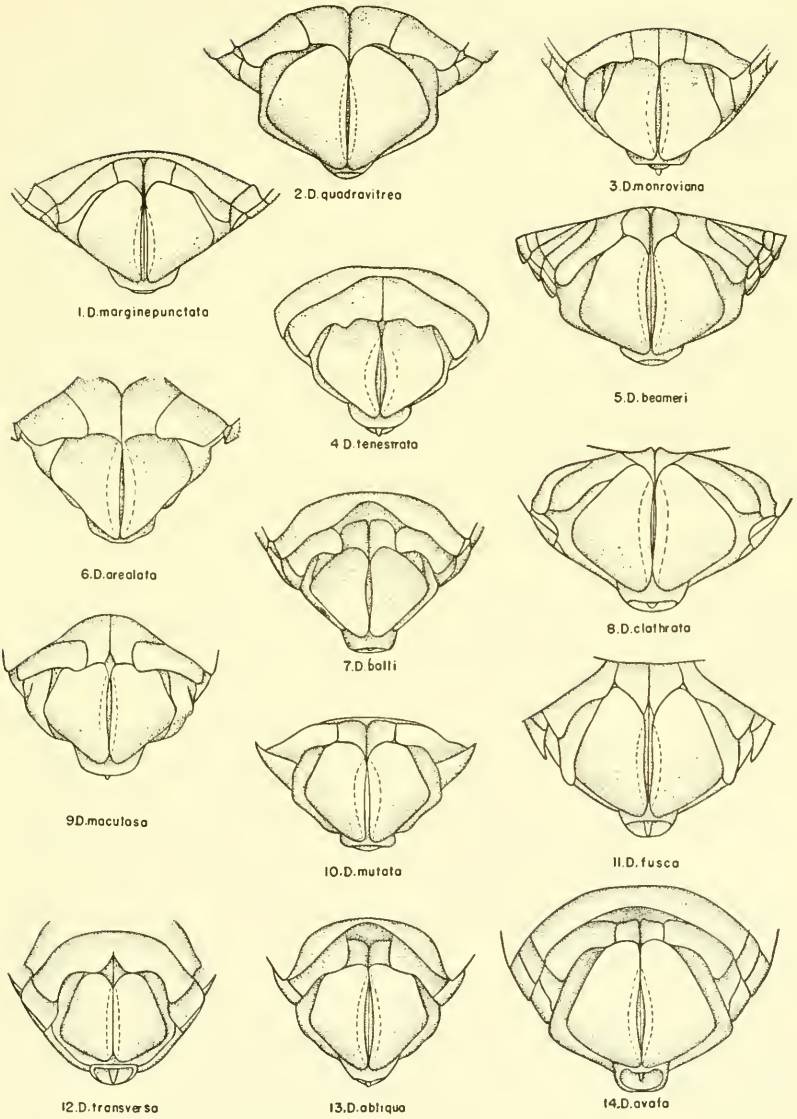

1.D. ovata
2.D. transversa
3.D.marginepunctata
4.D.monroviana
5.D mutata
6.D.obliqua
7 D fusca
8. D. clathrata
9.D. fenestrata
10.D.bolli
11.D.areolata
12. D.quadravitrea
13.D.maculasa
14.D. beameri
15.D.tenestrata
16. D. beameri
17.D.ovata
18.D. transversa
19.D marginepunctata
20.D.clathrata
21.D fusca
22.D.mutata
23.D.monroviana
24.D.balli
25 D.areolata
26 D. obliqua

PLATE XLII

FIGURE

1. Ventral aspect of the tip of the abdomen of the female of *Dictyssa marginepunctata.*
2. Same for *Dictyssa quadravitrea.*
3. Same for *Dictyssa monroviana.*
4. Same for *Dictyssa fenestrata.*
5. Same for *Dictyssa beameri.*
6. Same for *Dictyssa arcolata.*
7. Same for *Dictyssa balli.*
8. Same for *Dictyssa clathrata.*
9. Same for *Dictyssa maculosa.*
10. Same for *Dictyssa mutata.*
11. Same for *Dictyssa fusca.*
12. Same for *Dictyssa transversa.*
13. Same for *Dictyssa obliqua.*
14. Same for *Dictyssa ovata.*

PLATE XLII


1.D.marginepunctata
2.D.quadravitrea
3.D.monroviana
4.D.tenestrata
5.D.beameri
6.D.arealata
7.D.bolli
8.D.clathrata
9D.maculosa
10.D.mutata
11.D.fusca
12.D.transversa
13.D.obliqua
14.D.avata

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN
VOL. XXIV.] JULY 15, 1936 [No. 18.

Description of a new Mexican Subspecies of *Sceloporus spinosus* Wiegmann (Lacertilia)

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Department of Zoölogy, University of Kansas

ABSTRACT: *Sceloporus spinosus caeruleopunctatus* ssp. nov., is described from Cerro de San Luis, Oaxaca, Mexico. Types at University of Kansas.

AMONG the specimens collected in Mexico during the summer of 1935 by Dr. Edward H. Taylor and myself are four which represent an undescribed, distinct subspecies of *Sceloporus spinosus* Wiegmann, which may be described as follows:*

Sceloporus spinosus caeruleopunctatus ssp. n.

Holotype. EHT & HMS 8467, collected on the slopes of Cerro de San Luis, about 15 miles N. of Oaxaca, Oaxaca, August 5, 1935, by Hobart M. Smith. *Paratypes:* EHT and HMS 8464-6, from the type locality, same collector.

Diagnosis. Closely related to *spinosus spinosus,* differing in average scale characters and dorsal coloration. Dorsal scales from occiput to base of tail, 31 to 34 (30 or less in *s. spinosus*); ventrals, 47 to 52 (average, 45.6 in *s. spinosus*); femoral pores 9 to 13; lorilabials usually reduced to one row below subocular (rarely in *s. spinosus*); supraoculars, five to seven (rarely six, usually four in *s. spinosus*); prefrontals usually in contact medially (seldom in *s. spinosus*); some of the dorsal scales dark blue, coloration otherwise much as in *s. spinosus.*

Description of holotype. Head scales smooth, slightly convex, pitted; interparietal pentagonal; parietals single on either side, about two thirds size of interparietal; frontoparietals single on either side, more or less square, separated from each other medially by contact of frontal and interparietal; posterior section of frontal

* I am greatly indebted to Dr. Edward H. Taylor for making possible the study of these specimens, and for other courtesies and assistance. The study of the genus Sceloporus has been forwarded by grants from the Graduate Research Fund of the University of Kansas.

three fourths or four fifths size of anterior section; prefrontals in contact medially; three frontonasals, the lateral scales in contact with both canthals, median frontonasal distinctly larger than lateral frontonasals, and slightly larger than prefrontals; two pairs of internasals, the anterior pair separated from the rostral by a row of scales continuous with lorilabials; both pairs of internasals separated from first canthal by a small scale; supraoculars five-five, the anterior the smaller, the fourth slightly larger than others; a single, complete row of small, usually keeled scales separating supraoculars from median head scales; one complete and another incomplete row of scales separating supraoculars from superciliaries (except the first supraocular, which is in contact with first superciliary); five superciliaries visible from above; two canthals, the first not touching lorilabials nor forced above canthal ridge, the second forming a small portion of the superciliary series; subnasal present, approximately size of first canthal; loreal present, more or less square; preocular entire; subocular moderate in size, followed posteriorly by two small, strongly keeled postoculars; lorilabials in two rows, not reduced to one below subocular (usually reduced to one row); supralabials four, infralabials five-six to a point below middle of eye.

Mental pentagonal, with a labial border about three fifths that of rostral; mental followed posteriorly by three pairs of postmentals, the scales of only the anterior pair in contact medially; outer row of labiomentals separated from mental by partial contact of first postmental and first infralabial; inner row of labiomentals terminating below third infralabial; gular scales smooth, with one or two apical notches (usually one); anterior gular scales rounded, reduced in size; posterior gular scales subequal in size; gular scales below ear weakly keeled; scales in gular fold region with two or three apical notches.

Auricular lobules three, the upper the longest, but not reaching across ear; auricular lobules larger than preceding temporal scales; temporal scales weakly keeled, weakly mucronate toward eye, more strongly toward ear, somewhat smaller than largest scales between ear and lateral nuchal fold; ridge of skin overlapping lateral nuchal fold surmounted by strongly keeled, very strongly mucronate scales, which continue in an irregular row to a point below ear; scales between ear and insertion of foreleg keeled, rather strongly mucronate, strongly denticulate.

Dorsal scales keeled, rather strongly mucronate, denticulate, in parallel rows, the scales toward occiput reduced in size; median

lateral scales of somewhat the same general character as the dorsal scales, somewhat smaller than dorsal scales, somewhat more strongly keeled, in oblique rows; lateral scales toward axilla and groin becoming smaller, those in axilla almost granular, those in groin one half as large as median lateral scales, imbricating; ventral scales about one half or three fifths size of dorsal scales; scales on chest slightly larger than those on belly; interfemoral and preanal scales not or very slightly smaller than scales on belly; some of preanal scales rather porelike; all ventral scales smooth, with a single apical notch; dorsal scales on rump very slightly reduced in size; basal caudals on dorsal surface as large as largest dorsal scales on body; dorsal caudals strongly keeled, strongly mucronate, not or weakly denticulate, becoming smaller and more strongly keeled toward tip of tail; subcaudals smooth, rounded, becoming keeled distally on tail; enlarged postanals present, separated from each other medially by two small scales.

Dorsal scales of foreleg keeled, mucronate, denticulate, those on upper foreleg about one third size of dorsal scales on body, somewhat larger than those on lower foreleg; scales at elbow reduced in size; ventral scales of lower foreleg about as large as dorsal scales of same member, keeled except at extreme anterior edge; ventral scales on upper foreleg smooth (keeled anteriorly), usually notched, about one half or two thirds size of ventrals of lower forelegs, becoming smaller near axilla; lamellar formula for fingers 8-12-16-16-9 (8-12-16-16-10).

Dorsal scales of hind leg rather strongly keeled, mucronate, weakly denticulate, those on thigh somewhat larger than those on upper foreleg; dorsals on shank somewhat larger than those on thigh; ventral scales of shank smooth, notched, as large as dorsal scales of same member; scales on anterior surface of thigh nearly smooth, acuminate, with a single notch on either side of apex, the scales becoming quite smooth, with a single apical notch, and much smaller toward series of femoral pores; scales in a median area on posterior surface of thigh keeled, mucronate, much smaller than preanal scales; no postfemoral dermal pocket; lamellar formula for toes 8-13-16-19-12 (8-13-17-19-12).

Color. General dorsal coloration brownish-yellow; a dorsolateral light line on each side, about one and one half scales wide, extending from temporal region onto base of tail; below this the ground color is darker, sometimes concentrated into broad, indistinct dark bars separated by narrow lighter areas, not passing onto ventral surface

of abdomen; between the dorsolateral light lines are a number of dark-blue scales (the color usually fades in preservative) apparently arranged in two irregular rows; the heads of the two males are slate (rather dark in type), with numerous white flecks; among these the most distinct are: a light spot on each parietal, a light pineal spot with a small, dark, central spot, a light spot on each side at the posterior edge of interparietal, a light spot on each frontoparietal, a light, narrow bar across posterior section of frontal, and a light spot at the posterior, medial edge of the third supraocular; in the males an indefinite, brownish band crosses the head in front of the eyes, and is preceded by a darker brown area extending to the internasals; the internasal area, to the rostral, is light brown; the labia are irregularly marked with dark and very light brown; a dark spot in front of arm, extending dorsally a short distance, with a few scales of dark-blue color; the black shoulder spots are narrowly continuous with each other across neck; in the type, the anterior part of the gular area is white, the posterior part blue; in the male paratype, the whole throat is dark blue; in both specimens black, or dark blue, convergent bars are present in the gular region; the chest, a narrow area down middle of abdomen, prenanal region and the posterior part of the ventral surface of the thighs are white; on each side of belly is a broad area of blue, bordered medially by a narrow area of black or dark blue; the groin is black or dark blue, the color extending onto thighs; the chest has a few irregular spots of black.

In the females two rows of irregular, dark-brown spots are present between the dorsolateral light lines; the throat has indistinct bluish bars, and the sides of the abdomen have a bluish tinge.

The following notes from the field catalogue are pertinent: "*Large male.* Lighter parts of labial region and lighter parts of back tinged with reddish-orange, more distinct on head. Posterior gular region dark blue; sides of belly lighter, tinged with light green. Some of the scales of the back between the dorsolateral light lines dark blue. *Smaller male.* Lacks orange color of head. *Female.* In life, when shot, the blue spots on the back were very distinct. A few hours later, before preservation, the color had disappeared."

Habits and habitat. All specimens were found running about on the ground at low elevations, in more or less open areas, usually near rocks. They always ran into rocks or bushes at the first indication of danger, and were rather difficult to collect.

Remarks. According to my notes, taken hurriedly on a recent short trip to eastern museums, the following specimens apparently belong to this subspecies: AMNH 18804-14 (Tlacolula to San Pablo Mitla, Oaxaca, July 11-13, 1920, Paul D. R. Rüthling); FMNH 1011 (Oaxaca, Oaxaca, June, 1901, S. E. Meek); USNM 47534-5, 47396-7 (Oaxaca, Oaxaca, June 14, 1894, Nelson & Goldman).

Measurements (in mm.) and Scale Counts

Number	8465	8466	8464	8467
Snout to vent	80.0	82.0	82.5	94.0
Snout to occiput	15.0	15.0	15.0	17.0
Snout to ear	16.9	18.4	18.2	20.5
Hind leg	54.0	58.7	53.5	61.6
Fourth toe	20.7	22.4	20.5	23.0
Fifth toe	10.1	9.7	9.2	11.0
Tibia	15.9	16.8	14.6	17.0
Scales to head length	6.2	5.1	6.2	6.0
Lamellae, fourth toe	19–20	20–21	21–22	19–20
Femoral pores	12–13	10–12	11–12	9–12
Sex	♀	♂	♀	♂
Tail	100.0	115.0	103.0	126.0
Dorsals	34	31	33	31
Ventrals	51	47	52	52
Scales around body	42	38	43	40

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SCIENCE BULLETIN

VOL. XXIV.] JULY 15, 1936 [No. 19.

Notes on the Herpetological Fauna of the Mexican State of Sonora

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ABSTRACT: The report is based largely upon a collection of reptiles and amphibians, now at the University of Kansas, secured by Edward H. Taylor in Sonora during parts of the summer of 1934. An ecological classification is given of the species discussed (five of amphibians, eighteen of lizards, sixteen of snakes, and two of turtles). *Cnemidophorus burti* sp. nov. is described from La Posa, near Guaymas. An annotated bibliography of literature concerning the herpetological fauna of the state is appended.

THE fauna of Sonora is of special interest to students of American herpetology, because of the proximity of this region to the states of Arizona and New Mexico, and the fact that the southern boundary of the state is not far from the southern limit of distribution of the species characteristic of the Sonoran faunal region, at least of those forms that are adapted to a lowland habitat. At Mazatlán in southern Sinaloa, this fauna has been largely replaced by other species, a large number of which show strong Central American affinities.

Although much of the state has not been explored herpetologically, a few collections have been made, chiefly in the coastal region about Guaymas and along the highway between Nogales and Guaymas.

A few specimens were obtained by members of the Mexican Boundary Commission between the years 1852 and 1854, and it appears that certain of the "Sonora" localities were incorporated in Arizona and New Mexico after the Gadsden Purchase. Specimens from the commission are in the National Museum. Prof. J. T. Lovewell and Mr. Heiligbrodt collected in Sonora at a much later date. This collection, which was presented to Washburn College, Topeka, Kan., was made the basis of a special report by Cragin (1884). A collection made by Dr. Gustav Eisen and Walter Bryant in April and May, 1892, is in the California Academy of Sciences. It was the subject of a report by Van Denburgh (1897).

Certainly the most important collection made prior to my own is one made by Morrow J. Allen, Jean Piatt and John Scofield, sponsored by the Museum of Zoölogy, University of Michigan. The collection numbered 326 specimens, 59 amphibians and 267 reptiles, and was obtained chiefly at Puerto, Noria, Hermosillo and Guaymas in June and July, 1932. Allen (1933) has published data on this collection, listing four amphibians, twelve lizards, six snakes (the report on the two species of rattlesnakes is accredited to H. K. Gloyd) and one turtle.

I spent the time between June 19 and July 16, 1934, in Sonora studying the herpetological fauna. A considerable collection was made, chiefly in the localities previously visited by Allen, Piatt, and Scofield. A brief itinerary from my diary follows:

June 19. Entered Sonora at Nogales. Collected a few specimens along the road, and made a late afternoon camp, 53 miles south of Nogales.

June 20 and 21. Collected along the road, and camped at Noria, the evening of the 20th. On both nights some time was spent in the field collecting with a light.

June 22. A stop was made 30 miles south of Noria, and later I pitched camp about five miles southwest of Hermosillo, in a large boulder field near low mountains.

June 23 to 25. Collected at Hermosillo, spending a part of each night in the field. I broke camp the afternoon of the 25th and made a camp 51 miles south of Hermosillo, remaining there until noon of the following day.

June 26. Spent the morning afield, then drove to Guaymas. During the evening I collected near the beach at Miramar, a small resort three miles northwest of Guaymas.

June 27. Collected about Miramar and later made camp at LaPosa, about ten miles northwest of Guaymas. This place consists of three small houses and a nearby well, situated within a quarter mile of the beach.

June 28 to July 16. With the La Posa camp as a base, collecting was carried on within a five-mile radius. Several hours were spent collecting in the field with a light on most of the nights. In the immediate vicinity of La Posa are a few low mountains rising from sea level. To the north about one and one half miles there is a chain of low mountains, and two miles to the west are other low peaks in the vicinity of San Carlos Bay. The intervening terrain is gravelly and covered with sparse bush and cacti, with occasional

stunted trees. At this season the country was arid and none of the small streams carried any water. With the aid of friendly vaqueros of La Posa two small springs were located about two miles to the north of my camp. Here a few hylas and the ubiquitous *Rana pipiens* were found by the springs; elsewhere only a single amphibian was taken, this, a large *Bufo alvarius,* obtained at the La Posa well, at night.

During the period I spent at this camp, a few specimens were also collected at Miramar and along the road to Guaymas. Two trips (one during the day, one at night) were made to Empalme, ten miles southeast of Guaymas.

On June 16 I journeyed south into Sinaloa, and later into Nayarit to continue collecting. On my return to the north, I spent a few days, August 4-8, in the general vicinity of Guaymas (Miramar and La Posa). A few specimens were taken along the highway on the return to the border. I arrived at Nogales August 10.

In the general region about Guaymas the mountains come down to the sea, but at various points there are flat, sandy beaches limited by a dyke of sand built up by the waves. The line where this dyke and the shrub met was an especially fine locality for collecting. This terrain offered shelter for numerous rodents, insuring a constant food supply for the snakes.

An ecological classification would include four general habitats where collecting was done: beach line; low gravelly flats; low mountains; and springs. The fauna of each is recorded below.

BEACH LINE

Callisaurus inusitatus
Heloderma suspectum
Masticophis flagellum frenatum
Phyllorhynchus decurtatus decurtatus
Crotalus cinereous

SPRINGS

Hyla arenicolor
Rana pipiens
Thamnophis eques
Ficimia desertorum (accidental)

LOW MOUNTAINS

Phyllodactylus homolepidurus
Sauromaulus hispidus
Ctenosaura hemilopha
Uta taylori
Cnemidophorus burti
Constrictor constrictor imperator
Masticophis piceus
Crotalus molossus molossus
Crotalus tigris
Gopherus agassizii

LOW BRUSHY FLATS

Coleonyx variegatus
Dipso-saurus dorsalis sonoriensis
Holbrookia elegans thermophila
Uta ornata lateralis
Uta stansburiana stejnegeri
Sceloporus clarkii clarkii
Sceloporus magister magister
Phrynosoma solare
Cnemidophorus melanostethus
Constrictor constrictor imperator
Hypsiglena ochrorynchus
Masticophis flagellum frenatum
Thamnophis eques
Trimorphodon lambda
Tantilla hobartsmithi
Crotalus cinereous
Kinosternon sonoriense
Bufo punctatus
Bufo alvarius
Scaphiopus couchii

AMPHIBIANS

The amphibian collection makes no claim to completeness. Most of the time spent in Sonora was prior to the advent of summer rains, when much of the amphibian population was still in aestivation.

On my return to the United States in August I obtained a few amphibians in Guaymas and at Noria. In the latter locality I failed to find *Pternohyla fodiens* Boulenger and *Microhyla olivacea* (Hallowell), species which Allen (1933) found to be plentiful. *Bufo woodhousii* Girard and *Bufo marinus* (Linnaeus) have been reported by Kellogg (1932). The record for *Bufo compactilis* Wiegmann from this locality may be regarded as doubtful.

Scaphiopus couchii Baird

A single specimen (No. 1151) was captured late at night on dry sand near Noria. It appeared to have been attracted by my lantern light, and approached close to my camp. Four were taken near Guaymas on a flat during a light rain.

Bufo alvarius Girard

One specimen (No. 14) was taken at night at La Posa, ten miles northwest of Guaymas. Four typical, immature specimens (Nos. 1102-1105) were collected on the night of August 4, on a barren flat four miles north of Guaymas.

Bufo punctatus Baird and Girard

One specimen (No. 132) was captured with the four above-mentioned *alvarius*.

Hyla arenicolor Cope

A series of eleven specimens (Nos. 368-378) was obtained from the immediate vicinity of a spring, about two miles north of La Posa. Here there is a sudden break in the low range, and within the cleft is a small basin where numerous palm and fig trees grow luxuriantly. The frogs emerged at twilight from among the dead palm leaves, which hung suspended about the trunk of the palms, and approached the pools below the spring. Here they were captured as they sat in the edge of the water or on the banks. All appear to be half grown. They are marked with very distinct rounded spots on a lighter, grayish ground color.

Rana pipiens Schreber

Five recently transformed specimens (Nos. 379-383) were encountered in the same pools mentioned above. A few tadpoles, not yet transformed, were seen in the pools.

LIZARDS

Phyllodactylus homolepidurus Smith

Phyllodactylus homolepidurus Smith, Univ. Kansas Sci. Bull., XXII, Apr. 15, 1935, pp. 121-125, pl. XXV, fig. 2a and text fig. 1, A.

A series of twenty-six was collected at the following localities: twelve (including the type), five miles southwest of Hermosillo; eleven, from a point ten miles northwest of Guaymas; three, four miles southeast of Guaymas on the Empalme road. Smith (*loc. cit.*) has given a thorough account of these specimens.

Coleonyx variegatus (Baird)

Stenodactylus variegatus Baird, Proc. Acad. Nat. Sci., Phila., 1858, p. 254 (type description; type locality, Rio Grande and Gila Valleys).

Coleonyx variegatus Smith, Trans. Kansas Acad. Sci., XXXVI, 1933, pp. 301-314.

Thirty-eight specimens of *Coleonyx variegatus* (Baird) were collected in Sonora, and with one exception, in which the specimen was found hidden under a rock, they were discovered at night running about over gravelly soil near the beach and in the mountains.

These specimens agree with the characters noted by Smith (*loc. cit.*) as being diagnostic of this species. The preanal pores vary from six to nine, and the supranasals are invariably in contact medially behind the rostral. The cloacal bones agree with those typical of *variegatus* save there is a suggestion of a groove or notch at the exposed end in certain specimens. In markings, a number of the specimens show a tendency for the transverse bars to break medially and a suggestion of a median dorsal line is often evident. The bars on the tail do not extend ventrally as is typical in many specimens of *brevis*. The breaking up of the juvenile color pattern seems to begin a little later in life than is typical, since only the largest specimens (snout to vent, 60 mm.) show this condition.

The specimens of this species usually run with the tail lifted, often curved over the back. The bright light from my lantern tended to bewilder them, and they were caught at night with little difficulty.

I obtained specimens from the following Sonoran localities:

Nos. 123-124, 152-153, 176-177, five miles southwest of Hermosillo, June 22 to 24; Nos. 260, 267, 293-295, 301, 327-333, 396, 436-437, 458, 461-462, 383, 385, La Posa, ten miles northwest of Guaymas, June 29 to July 16; 1142-1146, 1178-1182, near La Posa, Guaymas, August 5 to 7; 1183-1187, five miles southwest of Hermosillo, August 8 and 9.

Ctenosaura hemilopha (Cope)

Ctenosaura hemilopha Smith, Univ. Kansas Sci. Bull., XXII, No. 6, Apr. 15, 1935, pp. 140-142, pl. XXIII, fig. 1.

Two specimens were collected; one from a locality ten miles northwest of Guaymas is figured by Smith. The second specimen is from five miles southwest of Hermosillo. Smith has discussed these specimens (*loc. cit.*).

Dipso-saurus dorsalis sonoriensis Allen

Specimens were taken at Hermosillo and Guaymas as follows: Topotypes, Nos. 180, 180a, five miles southwest Hermosillo, June 25; Nos. 296, 341, 362a, 419, 463, and 494-497 (skeletons), between July 2 and 12 in the general region about Miramar and La Posa; 1128-1129, northwest of Guaymas, August 7; 1127-1128, 1148-1149, near Miramar, August 7 and 8.

These specimens agree with the details of the type description. The two or three scale rows between the nostril and rostral (as occurs in the typical subspecies) is reduced in this form to a single series. This appears to be constant. The brown reticulation on the throat enclosing round or oval cream areas, the less distinct rows of dark spots forming caudal annuli, and the tendency to lose the ocellated spots on the neck and shoulders, are all characters that tend to separate these from the more northern forms. The labials are fewer and smaller.

All the specimens come within the limits of variation assigned to the form by Allen.

Crotaphytus collaris baileyi Stejneger

One male specimen (No. 1162) was taken about sixty-one miles south of Nogales. The throat is lavender, becoming purplish posteriorly and covered with cream reticulations. The spots in the temporal region are a light chocolate brown; the neckbands are widely broken below; body with slate bands separated by only

slightly lighter interspaces, the whole covered with tiny light-cream spots; tail with indistinct brown bands. The hind leg brought forward, the tibiotarsal articulation reaches the shoulder, the longest toe to a point somewhat in advance of the eye. Ventral surface of limbs, abdomen and tail, cream-white.

Snout to vent, 98 mm.; tail, 188 mm.; hind leg, 85 mm.; femoral pores, 16-19.

Sauromaulus townsendi Dickerson

Sauromaulus townsendi Schmidt, Bull. Amer. Mus. Nat. Hist., XLVI, Dec. 7, 1922, p. 643; Belding, West Amer. Scientist, III, 1887, pp. 97-99.

I collected three specimens of this species: one (No. 198) fifty-four miles southwest of Hermosillo; one (No. 222) at Miramar, three miles northwest of Guaymas; and one (No. 346) five miles north of Guaymas. All were discovered in rock crevices from which localities they were removed with considerable difficulty.

These specimens have been identified with Dickerson's species on the basis of the character of the interauricular scales and the large size of the caudal scales. Schmidt (*loc. cit.*) has pointed out that the species is, in several respects, intermediate between *S. obesus* and *S. hispidus* but actually distinct from both.

Measurements (Nos. 198 and 222, respectively [in millimeters]): Snout to vent, 126, 155; tail, 140, 122 (regenerated); head length, 28, 32; head width, 26, 32; body width, from edges of lateral folds, 54, 62; foreleg, 52, 61; hind leg, 78, 88. The number of scales in a single whorl about the tail at widest part, 64, 62; scales from gular fold to anus, 153, 143.

Color. No. 198. Above, the specimen is yellowish-tan and brown, the darker color forming five, rather indefinite, broad bands across the body. The tail with five, unequal, broad, dark-colored bands and five lighter bands, the terminal band narrow. The dorsal surface is marked with small spots, those on the dark bands larger than those on the lighter interspaces. Below, the body is a dirty cream with some lavender marbling on the throat. The ventral surface of the thigh has brown, punctate spots. The edges of the gular fold and the preauricular lobules are cream. The head is brown above.

The larger specimen (No. 222) is darker above than the preceding specimen. The general pattern of dark bands with lighter interspaces can be discerned with difficulty. There is only a slight contrast between the light and dark bands on the tail. The sides of the body have numerous small brown spots.

Callisaurus inusitatus Dickerson

Callisaurus inusitatus Dickerson, Bull. Amer. Mus. Nat. Hist., XLI, 1919, p. 465; Allen, Occ. Papers Mus. Zoöl. U. of Mich., No. 259, Apr. 3, 1933, pp. 7-8.

The following specimens were collected: Nos. 51, 52, twenty-five miles south of Nogales, June 20; No. 60, fifty-three miles south of Nogales, June 20; Nos. 83, 84, near Noria, June 22; Nos. 131, 132, and 178, five miles southwest of Hermosillo, June 23; Nos. 186, 188, fifty-four miles southwest of Hermosillo, June 28; Nos. 207, 208, Miramar, near Guaymas, July 29; Nos. 283-286, 290, 339-340, 347, 363-364, 396, 399-407, 423, 452-459, 464, 465, 486, 487, 504-506, 521, La Posa, June 29 to July 10; Nos. 1111-1117, 1121-1126, 1150, 1188-1190, La Posa and Miramar, August 4 to 6.

If Linsdale* is correct in his surmise that there is but a single species of *Callisaurus* on the peninsula of Lower California and the western United States, the form here considered would be *Callisaurus draconoides inusitatus.* I lack sufficient comparative material to either concur in, or disprove, his conclusions.

Holbrookia elegans thermophila (Barbour)

Holbrookia elegans thermophila Smith, Univ. Kansas Sci. Bull. XXII, No. 8, Apr. 15, 1935, pp. 194-195, pl. XXVII, fig. 1; pl. XXVIII, fig. 4. (Also, pp. 191-193.)

Sixty-eight specimens were collected at various points in Sonora, as follows: Fifty-three miles south of Nogales, two specimens; two, eight miles south of Magdalena; five near Noria; one, thirty miles south of Noria; three, five miles southwest of Hermosillo; five, fifty-four miles south of Hermosillo; fifty, ten miles northwest of Guaymas.

Smith (*loc. cit.*) has discussed this lot, and has given a series of measurements.

Uta taylori Smith

Uta taylori Smith, Univ. Kansas Sci. Bull., XXII, Apr. 15, 1935, pp. 158-166, pl. XXVI, fig. 3.

Thirty-one specimens, including the type, were collected as follows: Nos. 252-258, June 30; 280-284, July 1; 300, 304, July 2; 320, 321, 322, 323a on July 3; 335, July 4; 393, July 6; 474, 474a, July 12; 500, July 13; all from La Posa, ten miles northwest of Guaymas. Nos. 199-202, fifty-four miles southwest of Hermosillo, June 26; Nos. 448-450, from a locality twelve miles northwest of Guaymas, July 10.

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* Linsdale, Amphibians and Reptiles from Lower California. Univ. Cal. Publ. Zoöl., XXXVIII, No. 6, June 24, 1932, pp. 357-359.

Uta stansburiana stejnegeri Schmidt

Uta stansburiana stejnegeri Smith, Univ. Kans. Sci. Bull., XXII, Apr. 15, 1935, pp. 166-167.

A series of seven (Nos. 501-503, 514-517a) from near Empalme. See Smith (*loc. cit*) for comments on these specimens.

Uta ornata lateralis (Boulenger)

Uta ornata lateralis Smith, Univ. Kansas Sci. Bull., XXII, April 15, 1935, p. 179.

Thirty-nine specimens were taken at the following localities: Eight miles south of Magdalena; thirty miles south of Noria; five miles southwest of Hermosillo; La Posa, ten miles northwest of Guaymas. Smith (*loc. cit.*) discusses this series.

Sceloporus clarkii clarkii Baird and Girard

Sceloporus clarkii Baird and Girard, Proc. Acad. Nat. Sci., Philadelphia, VI, Aug., 1852, p. 127. (Type description; type locality, "Province of Sonora." John H. Clark, collector.) (Not improbably from southern Arizona or southern New Mexico.)

This species was found to be present in most of the localities where I collected. In this region the species was encountered, almost without exception, in trees. In New Mexico, in certain localities, it becomes adapted to a rock habitat along deep arroyos. In eastern Arizona, *magister magister* also occurs and is the more terrestrial form, while *clarkii clarkii* is chiefly arboreal in habit.

It may be remarked that *magister magister* has a range from Nevada to Texas and southern Sonora—a range that includes the smaller range of *clarkii clarkii*. Nowhere is there any evidence of intergradation. Certain scale differences are constant and other differentiating characters of equal specific importance, suffice to enable each to maintain complete distinction from the other.

The following specimens were taken: Nos. 47-48, twenty-five miles south of Nogales, June 19; 54-57, about fifty-three miles south of Nogales, June 19; 65-68, Noria, June 20 (skeletonized); 74, thirty miles south of Noria, June 20; 105-106, thirty miles south of Noria, June 22 (skeletons); 116, 122, five miles southwest of Hermosillo, June 24; 182, fifty miles south of Hermosillo, June 24; 230, 306, 316-319, 336, 367, 386-391, 325-429, 429a, 429b, in the vicinity of La Posa, ten miles northwest of Guaymas, June 29, July 9; 524, Miramar, July 9; 1164, fifty miles south of Nogales, August 10.

Sceloporus magister magister Hallowell

Sceloporus magister Hallowell, Proc. Acad. Nat. Sci. Phila., VII, 1854, p. 93 (type description; type locality, Yuma, Ariz.).

Eight specimens were collected in Sonora, as follows: Nos. 81-82, near Noria, June 20, in a hole in a tree; 292, yg., La Posa, ten miles northwest of Guaymas, July 1; 408, July 7, La Posa; 420, La Posa, July 9 (skeleton); 466 and 466a, San Carlos Bay, July 12; 1152, La Posa, August 8.

This species† was usually encountered feeding in trees or on cactus. It appears to have burrows or at least takes refuge in burrows about the roots of plants. The stomachs were filled chiefly with flowers at this season.

One specimen (No. 420, skeletonized) contained nineteen well-developed eggs. The head and neck of the specimen was distinctly reddish in life.

Phrynosoma solare Gray

Specimens of this species were collected as follows: No. 179, southwest of Hermosillo, enroute to Guaymas, June 25; 259, ten miles northwest of Guaymas, July 8; 512, on the beach road near Empalme, July 13; 1110, in a street in Guaymas; 1156-1157, in the highway near Santa Ana, August 10.

All of these specimens, save one, were encountered in the mornings, along roads. A single one was taken under a low shrub, in partial shade, about 2:30 in the afternoon.

Compared with Arizona specimens from Tucson, the Sonoran specimens exhibit the same general color patterns. The horns surrounding the back of the head appear to be slightly longer in the males and the scales growing from the edge of the lateral skinfold (below the lateral spine series) are somewhat larger. All the specimens have the belly whitish or rusty white, with numerous, punctate, black spots.

Heloderma suspectum Cope

Three specimens of this species were collected at night near La Posa. Two (Nos. 263, 264) were captured in the sand near the point of meeting of the sandy beach and the shrub. (No. 264 has been skeletonized.) No. 205 was found on the top of the low mountain rising from the edge of the sea.

This last specimen was captured and placed in a sugar sack. On picking up my "snake stick" which had fallen near the sack, the

† More complete data on this form and *S. clarkii clarkii* will appear in a work by Hobart M. Smith treating of Mexican and American Sceloporı.

Heloderma made a quick lunge, and seized the third finger of my right hand, sinking the teeth to the bone. With a quick jerk, I tore my finger from the animal's mouth, thus widely opening the wounds. After sucking the wounds, the fingers were wrapped up and collecting continued. There was no ill effect, other than that which any wound of like extent would cause. No effects that could be attributed to venom could be observed.

Cnemidophorus melanostethus Cope

Cnemidophorus melanostethus Cope, Proc. Acad. Nat. Sci., Philadelphia, 1863, p. 104 (type description; type locality "Region of the Colorado of California," H. B. Möllhausen, collector).

Cnemidophorus tessellatus aethiops Cope, Ann. Rep. U. S. Nat. Mus., 1898 (1900), p. 582 (type description; type locality, Hermosillo, Son., Mex. Jenkins and Evermann, collectors).

Cnemidophorus tessellatus tessellatus Allen, Occ. Papers Mus. Zoöl. U. of Mich., No. 259, 1933, p. 10 (Puerto, Hermosillo, and Guaymas, Sonora).

I observed this species in 1934 at a number of localities along the highway between Nogales and Guaymas, in fact, it was one of the most common of Sonoran lizards. The following are in the collection: Nos. 91-95, 96, 96a, 99-100, June 21, near Noria; 114, thirty miles south of Noria, June 22; 133-136, 161-165, five miles southwest of Hermosillo, June 23-25; 220, 231-232, 232a-232b, 238, 270-271, 297, 313-315, near La Posa, ten miles northwest of Guaymas, June 28 to July 5; 358-362, near Miramar, three miles northwest of Guaymas, July 5; 404, 475-476a, 507-510a, July 14, near La Posa; 1118-1119, 1130-1134a, near Guaymas, August 5-7, 1934. Several other specimens have been skeletonized.

Cnemidophorus burti sp. nov.

(Plate XLII, fig.. 2.)

Holotype. No. 269, collected near La Posa, ten miles northwest of Guaymas, Sonora, July 4, 1934; E. H. Taylor, collector. Paratypes Nos. 239, 268, 311 (skeleton), 312, 392, 442, 443, all from the region about La Posa, collected from June 20 to July 10.

Diagnosis. Related to *C. perplexus*, but with a tendency toward a reversal of the typical color pattern. The young are five-lined; brownish or tan dots on a dark-brown background between much widened, bright, cream-colored, lateral lines, and between the dorsolateral and the broad, lavender, median lines. Most of the older specimens lose practically all trace of the dots and the pair of lateral lines on each side are strongly intensified, while the median becomes dim lavender to reddish in color. The ground color becomes dark or light reddish-brown.

Description of the type. Rostral typical, the part visible above longer than the nasal suture, but shorter than the frontonasal; frontal single, once and one fourth as long as broad; two frontoparietals, their greatest combined width equal to two thirds the combined width of the parietal series; three parietals, followed by a group of scales, the one bordering the outer lower edge of the outer parietals largest; four supraoculars, the anterior triangular and of about the same area as the last, the first three touching the frontal; last three supraoculars separated from superciliary series by a single row of small granular scales, and the third supraocular partially and the fourth wholly separated from the frontoparietals. Six-seven superciliary scales; eyelid with a row of seven small plates higher than long; enlarged upper labials 5-5; enlarged lower labials 7-8, the anterior much reduced.

Mental rounded, followed by a single undivided postmental; five pairs of chinshields (sublabials), only the first pair in contact, the last separated from the mouth angle by two pairs of moderately enlarged scales only partially in contact with the labials; postnasal large, much higher than wide, followed by a much larger loreal, and a very small scale segmented from the lower posterior corner of the loreal; two preoculars, each keeled along the upper, inner border; subocular elongate, with a low keel, followed by two postsuboculars; a series of enlarged temporals, continuous with the superciliaries, flanked above and below by somewhat smaller scales. Auricular opening large, D-shaped; enlarged anterior gular series extending across the ventral surface, separated from the first gular fold by fourteen rows of subequal scales; three rows of smaller scales in first fold; five rows of scales between the anterior and posterior folds, becoming much enlarged posteriorly; eleven rows of granular scales in the posterior fold.

Venter with six complete series and two outer incomplete series of much widened ventral scutes, the two median somewhat narrower than others; about thirty-six transverse rows from gular fold granules to the femoral pores. Upper arm with five, lower with three rows of enlarged scales (brachials and antebrachials) on front of arm; the postantebrachials distinctly enlarged; femoral pores, 18-19; tail elongate, tapering; scale rows around body, 98 (not including enlarged ventrals).

Color in life. Above blackish-brown with five longitudinal light stripes from head to groin or to base of tail; the dorsolateral and median lines extend onto the tail some distance; the light stripes are

distinctly more than half the width of the intervening dark stripe; the median light line forks on the neck and is lilac to lavender in color. The lateral stripes are cream anteriorly, becoming light lavender posteriorly. There is no trace of spots. Ventral surfaces cream, immaculate. Top of head uniform olive.

Measurements (in mm.) of holotype and paratypes of *Cnemidophorus burti*, sp. nov.

Number	268	442	392	312	269	443	239
Sex	♂	♂	♂	♀	♂	yg.	yg.
Snout to vent	85	85	85	80	78	68	64
Tail	240	.....	233	.....	235	197	183
Width of head, temporal	13.5	13.2	14	12	13	9	10
Length of head, rostral to back of parietals	17	19.5	19	17	19	15	14
Width of head, across eyelids	9	9	9	7.5	9	7	6.5
Snout to ear	19	19.5	19.8	18	18	16	14.5
Snout to foreleg	32	35	31	28	29.5	22	24
Axilla to groin	39	38	38	42	38	34	30
Foreleg	30	29	30	30	27	26	23.5
Hind leg	61	58	56	58	55	53	45

Variation. In color the youngest specimen (No. 239) shows a well-defined series of spots on the darker background between the light lines; these have practically disappeared in No. 443, which is a few millimeters larger. Otherwise, the color pattern is practically unvaried in the remainder of the series, save that the ground color tends towards a red-brown in most of the specimens.

Scale rows around the body vary between 93 and 99, the average being about 97.

Remarks. Burt (Bull. U. S. Nat. Mus., No. 154, 1931, p. 132) mentions a specimen of this form from near Guaymas, Sonora, under the name of *C. sexlineatus perplexus*, and Allen (Occ. Papers Mus. Zoöl., U. of Mich., No. 259, 1933, p. 10), likewise mentions one of this species from Guaymas. The coloration is, as suggested by Burt, strongly reminiscent of that of *hyperythrus*. The species is named for Dr. Charles Burt, who has made the genus *Cnemidophorus* his particular field of study.

Cnemidophorus perplexus Baird and Girard

Cnemidophorus perplexus Baird and Girard, Proc. Acad. Nat. Sci., Philadelphia, 1852, p. 128 (type description; type locality—Valley of the Rio San Pedro. Also collected by General Churchill, on the Rio Grande, west of San Antonio, Texas, and by Dr. William Gambel on his last journey to California).

The proper identity of numerous populations of Cnemidophorus in the southwestern part of the United States is, I believe, still in question. Burt (1931, Bull. U. S. Nat. Mus., No. 154) has the identification problem solved by placing most of the named forms in the synonymy of *sexlineatus perplexus* and *tessellatus tessellatus*.

Since the modern tendency in systematic taxonomy is the recognition by name of variant populations which cover a considerable range, it seems likely that certain of the names now in synonymy will of necessity be resurrected for such variant populations whose differential characters are not wholly due to differences in age or sex.

The species here considered as *Cnemidophorus perplexus* differs from western Texas (type locality) specimens in several characters, not the least important of which is a much larger number of scale rows around the middle of the body. A series of sixteen specimens from western Texas and southeastern New Mexico have a range from 64 to 72 scale rows around the middle of the body, the average being 68. The series from Hermosillo, in the central northern part of Sonora (Nos. 156-160, June 23-25, 1934; E. H. Taylor, collector), vary between 89 and 95, the average being about 92. The femoral pores are 16-19, the average being 18; this number appears seven times (in 12 femora counted), 19 twice, 17 twice, 16 once; a specimen (No. 189) taken fifty-four miles southwest of Hermosillo has 95 scale rows.

The series shows age transitions from a six-lined form to one with a series of twelve rows or rounded, light spots, largest on the sides, less distinct and smaller on the median dorsal region, those on the nuchal region obsolete. The specimen (No. 189) taken fifty-four miles southwest of Hermosillo has the two median lines tending toward a fusion in the middle of the back; they are separate posteriorly and are obscured by the brownish color in the neck region.

It is probable that this form should be recognized as a subspecies of *perplexus*. It seems that the young lack the bluish ventral and caudal coloration and there is an average difference in the adult color pattern. However, in general, these follow the expected individual evolution of the color pattern for *perplexus* (typical).

SNAKES

Lichanura roseofusca gracia Klauber

Lichanura roseofusca gracia Klauber, Trans. San Diego Soc. Nat. Hist., VI, No. 20, Apr. 30, 1931, pp. 305-318, pl. 21, fig. 1; and Copeia, No. 4, Dec. 27, 1933, pp. 214-215.

The report of a form of *Lichanura* (Klauber, 1933) at Guaymas, Sonora, anticipates the capture of my specimen from near Hermosillo, which lies about seventy-five miles north of Guaymas.

The specimen (No. 129) was captured June 29, 1934, just after daybreak in a mass of boulders five miles southwest of Hermosillo. It is a pregnant female with the embryos probably two thirds developed. No fear was shown at my approach and when picked up the snake remained quite docile. The embryos were removed when it was preserved. These are Nos. 166-169. They show the typical striped color pattern of the mother.

The measurements (in millimeters) and scale counts are as follows: Snout to vent, 546; tail, 62 (injured); ventrals, 223; subcaudals, 40; scale rows, neck 40, about body 43, in front of anus 25. The young measure about 160 to 172 in total length, the tails measuring about 25 mm.

Three of the young are males, with the hemipenes still completely extruded; one is a female; the latter has slightly shorter tail than the males. The following table shows the scale counts of these specimens:

No.	Sex	Ventrals	Subcaudals
166	♂	223	49
167	♂	220	47
168	♂	223	48
169	♀	227	48

Constrictor constrictor imperator (Daudin)

Constrictor constrictor imperator Allen, Occ. Papers. Mus. Zoöl., U. of Mich., No. 259, Apr. 3, 1933, p. 11 (Hermosillo).

Three specimens of this boa were taken in the neighborhood of La Posa. One was skeletonized, the other two were brought back to Lawrence, Kan., alive. All are typical.

One was found in the mouth of a small cave, in which was observed on several occasions the track of what appeared to be a very large specimen of this species. One specimen, a female, was captured in a tree cactus about five feet from the ground. A third was captured at night crawling along a dry arroyo.

The capture of this snake by Allen (1933) at Hermosillo suggests the possibility of its being eventually discovered in some of the mountain ranges of southern and southwestern Arizona.

Masticophis flagellum frenatum Stejneger

Masticophis flagellum frenatus Ortenburger, Mem. Univ. Mich. Mus., I, 1928, pp. 112-125, pls. XX, XXI.

A specimen collected in a low tree on the edge of the beach at La Posa is referred to *frenatus*. This specimen (No. 395) is uniform brown-olive, each scale showing a lighter area on the anterior median part. This lighter area becomes more distinct posteriorly. There is some evidence of spots on the labials, and the loreal and posterior nasal seem to be more yellow than the scales above and below. The anterior ventrals have a double row of median spots which are more evident anteriorly.

A second specimen (No. 513), captured near Empalme, is slightly darker than the preceding, but there is no trace of the dark bands. The dark, labial spots are dimly visible, while the anterior ventral and mental spots are quite distinct. The loreal line is dimly visible.

A third specimen (No. 1460) was collected near Santa Ana in northern Sonora. This young specimen has the typical coloration, but even in the young the transverse markings are not pronounced. The head markings are, however, typical of *frenatus*. The anterior ventral spotting is irregular, the spots being in about four rows.

A large specimen (No. 1137) of the "red" phase of this species was captured near Guaymas, and brought alive to Kansas University. At first the specimen was shy and timid, attempting to escape as one approached the cage, striking when a hand was placed in the cage. Later it became very tame, permitting itself to be force-fed on beef without resistance.

Measurements and Scale Counts of *Masticophis flagellum frenatum* Stejneger

No.	*Ventrals*	*Sub-caudals*	*Upper labials*	*Post-oculars*	*Scale formula*	*Total length*	*Tail length*
513	203	97	8-8	2-2	22, 17, 15, 13, 12	1810	450
395	201	110	8-8	2-2	22, 17, 17, 13, 12	1292	246
1160	196	99	8-8	2-2	21, 17, 17, 13, 12	935	242
1137	197	106	8-8	2-2		1760	415

Masticophis piceus (Cope)

Masticophis piceus Ortenburger, Mem. Univ. Mich. Mus. Zoöl., I, 1928, pp. 112-125, pls. XX, XXI; Allen, Occ. Papers Mus. Zoöl. Univ. Mich., No. 259, Apr. 3, 1933, p. 11. (Hermosillo).

Two specimens were captured in Sonora. The first (No. 113) was collected thirty miles south of Noria near the highway. It was dis-

covered extending its head from a woodpecker hole, in a tree, about thirty feet from the ground, and was shot. This specimen is of a deep, blue-black color, save that toward the tip of the tail the color becomes brownish-black. On the ventral surface on the posterior half of the body there is an infusion of brown, becoming lighter posteriorly. On the last fifth of the body there are a few yellow flecks. In the anal region these form larger yellow areas. The inner edges of the subcaudals are light colored. Two other specimens seen escaped into holes in a hollow branch of the same tree.

No. 379. The anterior half of the body is black. About the middle of body there are three black-spotted, reddish bands, while the latter third of the body is more or less reddish. The tail is uniformly reddish-brown. The specimen was captured in the heat of the day under a flat rock, near La Posa.

These specimens seem to be common in the trees along small ravines. At least eight specimens seen escaped into holes in the boles or branches.

Scale Counts and Measurements (in mm.) of *Masticophis piceus* (Cope)

No.	*Sex*	*Ventrals*	*Anal*	*Subcaudals*	*Upper labials*	*Lower labials*	*Preoculars*	*Scale formula*	*Total length*	*Tail length*
113	♂	205	2	96	8-8	9-9	2-2	19, 17, 16, 13, 12	1460*	383
479	♂	200	2	113	8-9	11-12	2-2	21, 17, 17, 12, 12	1468*	395

* Tip of tail missing.

Masticophis semilineatus (Cope)

Masticophis semilineatus Ortenburger, Mem. Univ. Mich. Mus., I, 1928, pp. 48-57, pls. XI, XII, XIII, and text figs. 6, 7, 8; Allen, Occ. Papers Mus. Zoöl. Univ. Mich., No. 259, April 3, 1933, p. 11 (Hermosillo).

Three specimens of this species were taken. No. 155 was captured five miles southwest of Hermosillo at night in a bush; Nos. 234 and 325 were taken in the morning, at La Posa. No. 425, taken in a deep canyon in the mountains near La Posa, has been skeletonized.

These specimens agree well with specimens described and figured by Ortenburger (*loc. cit.*) and the scale counts are well within the known range of variation.

Scale Counts and Measurements (in mm.) of *Masticophis semilineatus* (Cope)

No.	*Sex*	*Ventrals*	*Subcaudals*	*Upper labials*	*Lower labials*	*Scale rows*	*Total length*	*Tail length*
155†	?	...	...	8-8	10-10	20, 17, 17, ?	...	...
325	♀	203	135	8-8	9-9	20, 17, 16, 13	1127	354
234*	♂	202	88+	8-8	8-9	20, 17, 17, 13	1084	265+

* Tip of tail missing.

† Posterior part of body wanting.

Salvadora grahamiae hexalepis (Cope)

Salvadora grahamiae Baird and Girard, Cat. N. Amer. Rept., pt. 1, 1853, p. 104 (Sonora, Mex.; Col. J. D. Graham, collector).

A specimen of *S. g. hexalepis* (No. 1163) was found dead under a rock at a point on the highway fifty miles south of Nogales. It consisted of a skeleton with dried skin sufficient to identify the species.

Phyllorhynchus decurtatus decurtatus (Cope)

Phyllorhynchus decurtatus decurtatus Linsdale, (part) Copeia, No. 4, 1933, p. 222; Klauber, Bull. Zoöl. Soc. San Diego, No. 12, Sept. 12, 1935, pp. 5-9.

Three specimens of *Phyllorhynchus* were collected in southern Sonora. No. 457 ♀ was found at La Posa running rather rapidly near some shrubs, about twenty-five meters from the sea, the night of July 10. No. 483 ♂ was discovered at La Posa by following a snake's trail in loose dry sand on the beach, the night of July 12. A third specimen, No. 1100 ♂, was found on a barren flat near the sea about four miles north of Guaymas, the night of August 4.

Data and Measurements of *Phyllorhynchus decurtatus decurtatus* (Cope)

No.	*Sex*	*Length*	*Tail*	*Ventrals*	*Subcaudals*	*Scale rows*	*Upper labials*	*Lower labials*
457	♀	284	27	165	25	24-19-19	7-6	9-9
483	♂	273	49	151	34	23-19-17	6-7	9-9
1100	♂	296	44	152	31	20-19-16	6-6	9-9

No.	*Oculars*	*Loreals*	*Dorsal spots body*	*Dorsal spots tail*
457	8-8	3-3	42	7
483	8-8	2-2	25	5
1100	7-6	1-1	28	5

The first specimen (No. 457) is a female, and the scales are smooth save for a very faint suggestion of keels along the posterior half of the body. No. 483 has the scales strongly keeled on the nine dorsal scale rows, the keels beginning about one centimeter back of the head; No. 1100 has the scales of the nine median dorsal rows even more strongly keeled than the preceding.

These three specimens were taken in the same general locality, all less than five miles apart, and two of these, a male and a female, within a few yards of each other. These are, apparently, specimens of the same species, but there are strong differences in markings, perhaps due to sexual dimorphism.

Linsdale believes a specimen taken at Caborca, Sonora, having faint keels, should be referred to *browni*, but as a subspecies of *decurtatus*.

The specimens listed here have been studied by L. M. Klauber in his recent review of the genus *Phyllorhynchus* (*loc. cit.*). I have followed him in the disposition of the specimens.

They present the following characteristics: Snout with a curved band rising on fifth and sixth labials, passing through eye and across the anterior part of the frontal to the opposite side of head; a second band crosses just behind the parietals and the ends run back varying distances on the side of the neck, on either side of the large nuchal spot; the area between these two bands on the head is variously spotted, or the two bands may be joined by confluent spots. A light spot on the frontal is enclosed wholly or partially by dark color.

The first two dorsal spots are confluent in the males but divided in the female. The first few dorsal spots are deep, black-brown. The dorsal spots on the males have darker borders; in the female, this darker border is scarcely evident. In the males the dorsal spots total 30, and 33; in the female, 50.

There is an irregular series of lateral spots in the males; in the female these are more numerous and less distinctly outlined.

Pituophis sayi affinis (Hallowell)

Pituophis sayi affinis Stull, Occ. Papers Mus. Zoöl. Univ. Mich., No. 250, Oct. 12, 1932, p. 4.

A single specimen (No. 80) was collected on the morning of June 20 in the shade of a small tree in the arid region near Noria. It remained motionless until I approached and grasped it.

It presents the following characters: Four prefrontals; rostral entering between the internasals nearly half their length; loreal elongate; one pre-, three postoculars; 8-8 upper labials, the fourth entering orbit; 12-13 lower labials, six touching the first chinshield; scale rows, 29, 31, 33, 33, 23; ventrals, 235; anal, single; subcaudals, 57; blotches on body, 46; blotches on tail, 12; anterior two thirds of body has the lateral spots more or less confluent with the dorsal blotches and the yellow cream interspaces form small spots occupying 9 to 12 scales on the sides; the light scales have a brown keel.

The head is yellowish posteriorly, with small black flecks; a curved band slightly anterior to eyes; a diagonal line from postoculars to the last labial; labial sutures brown; a series of brown spots on the ventrals and subcaudals, somewhat confluent under tail.

Ficimia desertorum Taylor

(Plate XLIII, fig. 1.)

Ficimia desertorum Taylor, Proc. Biol. Soc. Wash., Vol. 49, May 1, 1936, pp. 51-52.

The type specimen was discovered near a spring, about one and a half miles northeast of La Posa, ten miles northwest of Guaymas. It had been injured, and ants had destroyed a few scales. This spring is a few hundred yards farther east than the opening of the canyon in which was a spring mentioned elsewhere.

Hypsiglena orchrorhynchus Cope

Hypsiglena ochrorhyncha Cragin, Bull. Washburn Lab. Nat. Hist., Sept., 1884, No. 1, pp. 6-8 (Guaymas); Allen, Occ. Papers Mus. Zoöl. Univ. of Michigan, No. 259, Apr. 3, 1933, p. 12 (Hermosillo).

The Cragin (1884) record of one specimen from Guaymas is the earliest known for Sonora. It was collected by Prof. J. T. Lovewell. Allen obtained a specimen at Hermosillo.

I collected three specimens. No. 120 was taken in the boulder field five miles southwest of Hermosillo. It was found at dusk under the edge of my car step, June 22. No. 266 was caught in camp at La Posa, ten miles northwest of Guaymas, June 30; and No. 281 was discovered under a rock, under an overhanging cliff, near San Carlos Bay, two miles west of La Posa, July 1.

The ground color of the three specimens varies from an ash-gray in No. 281 to a brownish-gray in No. 120, and to a lavender-gray in No. 266. The characteristic neck- and head-marking consists of a dark-brown spot which fails to reach the ventrals by three scale rows. From the lower anterior edges, branches, on each side, run across the temples through the eyes to the rostral, but fail to meet anteriorly, widest on the temples; dorsally the blotch has a median forward projection which reaches the parietals. The whole blotch is outlined by an indistinct cream line which becomes a very distinct white on the sides. It follows the upper edges of the anterior labials, passes diagonally across the posterior labials and the angle of the mouth and may be continued back along the neck a short distance. In two specimens the neck band is broken unequally in twain by a cream-white line running longitudinally. The dorsal markings on the body are typical in all.

The three specimens agree in the following characters: The nostril is between two nasals; a loreal present; two preoculars, the upper very large, the lower very small and below the anterior part of the eye. Two postoculars, the upper largest. Temporals. 1+2;

eight upper, nine lower labials (No. 281 has seven upper labials on right side, due to a fusion of the second and third); five labials touching the first chinshields; anal divided.

Measurements (in mm.) and scale counts of *Hypsiglena ochrorhynchus* (Cope)

No.	*Sex*	*Total length*	*Tail*	*Ventrals*	*Subcaudals*
120	♂	325	74	178	60
266	♀	339	69	177	54
281	♂	226	73	181	63

Thamnophis eques (Reuss)

Thamnophis eques Ruthven, Bull. U. S. Nat. Mus., No. 61, 1908, pp. 158-164.

Eight specimens were taken, all in the general neighborhood of La Posa, which appear to differ but little from highland specimens from Mexico and the United States.

Ruthven (*loc. cit.*) has suggested that the species is absent from the coastal plain. These specimens demonstrate its presence at sea level, at least in the region about Guaymas. Cragin's (1884) record of *Eutaenia cyrtopsis** from Guaymas has been referred to this species.

Trimorphodon lambda Cope

Trimorphodon lambda Cope, Proc. Amer. Phil. Soc., 1885, pp. 286-287 (type description; type locality, Guaymas, Sonora. Type, No. 13487, U. S. N. M. H. F. Emerich, collector); Cope, Ann. Rep. U. S. Nat. Mus., 1898 (1900), p. 1104.

The retention of Cope's Sonoran species of *Trimorphodon* seems warranted despite the rather striking resemblance of the color pattern to certain Mexican and American forms. As yet, no series of sufficient size is available to properly evaluate the various characters on which most of the species of this genus have been established.

Klauber (1928), in his review of *Trimorphodon* in Baja California, California, and Arizona, recognizes the Arizona specimens from the Huachuca Mountains region as belonging to the species *T. lyrophanes,* and makes no effort to place *lambda* in the synonymy of that form. I have no *lyrophanes* available for making a critical comparison.

I obtained three specimens (Nos. 265, 366, and 341) in the general vicinity of Guaymas. The first was captured near La Posa crawling on gravelly ground at sea level, near my tent about midnight. It stopped and remained quiet, allowing itself to be picked up without struggling, and without endeavoring to bite. No. 336 was found at night in similar terrain near the beach. A third was captured in a

* I have endeavored to find this specimen in the collection of Washburn College at Topeka, Kan., but it appears to be lost.

niche in a low rock cliff near the sea about ten o'clock in the morning. The specimen was tightly coiled and was picked up in this condition, the specimen remaining coiled when captured, making no attempt at resistance. The last mentioned has been skeletonized.

My specimens Nos. 265 and 336 present the following characters: sex, ♂, ♂; scale counts at various points on body, 28, 19, 22, 22, 22, 16, 16; 29, 19, 21, 22, 22, 17, 15; ventrals, 232, 222; subcaudals, 83, 87; anals, 2, 2; supralabials, 9-9, 9-9; infralabials, 12-13, 11-12; preoculars, 3-3, 3-3; postoculars 3-3, 3-3; temporals, 3, 3, 4, 5; 3, 3, 3, 4; loreals, 2-2, 2-2; total length, 721 mm., 788 mm.; tail, 132 mm., 155 mm.; head length to jaw angle, 20, 25; head width, 14, 15; spots on body, 29, 31; spots on tail, 17, 18; spots separated by scales, 3½-4, 3½-4; labials enter eye, 4-5, 4-5.

The diameter of eye equals the distance of eye to nostril, in the first, and very slightly less in the second; the frontal is longer than its distance from the end of the snout; the prefrontals are as long as wide; frontal longer than parietal width, shorter than parietal length; preocular is not in contact with frontal in either.

The type has 234 ventrals; anal divided; subcaudals, 83. It agrees in the remainder of the characters so far as stated save that there are three loreals. This condition is probably anomalous, and occurs occasionally in several other species.

The body markings of *lambda* consist of a series of saddlelike brownish blotches, with a whitish to a light gray transverse center, and bordered completely with the same color. The blotches are about four scale rows wide dorsally, narrowing to a single scale width laterally; they reach to the outer scale row. Between these blotches are other brownish-gray blotches which are about two scale rows wide dorsally, and five scale rows wide laterally; a more or less regular series of distinct, brownish spots on the outer edge of every second or third ventral, which may extend on the adjoining scales; rarely are these spots confluent with the dark dorsal blotches; ventrals with other dim brownish flecks. The head markings consist of a series of chevrons, the one across the snout brownish, followed by a narrow grayish band on the anterior part of the prefrontals; this is followed by a broader brown band which passes through eye diagonally and terminates on the upper part of the fifth and sixth labials; next to this appears an irregular grayish chevron, followed by another which is broad, irregular, brownish, much lighter laterally, showing two darker spots on the supraoculars. A white dot present on the posterior part of the frontal which is

confluent with the gray chevron which follows. This chevron forms the light anterior border for the first dorsal blotch, which is grayish-brown with a circular gray medium dorsal spot.

In the smaller specimen (No. 265) the markings between the blotches themselves are a little darker and the ventral flecks fewer than in the larger (described) specimen.

Tantilla hobartsmithi Taylor

Tantilla hobartsmithi Taylor, Trans. Kan. Acad. Sci. XXXIX, 1936, pp. 340-342, fig. 2.

Only the type was captured. This was taken at a point about two miles north of La Posa, back of the first low range on the bank of a dry stream bed at night. The specimen was running rapidly over gravelly soil under brush.

Crotalus cinereous Le Conte

Caudisona atrox sonoraensis, Kennicott, Proc. Acad. Nat. Sci. Phila., Aug., 1861, pp. 206-207.

This species was especially abundant in the southern part of the province. Eleven specimens were captured in the neighborhood of Miramar and La Posa, and several which were seen escaped. Several decapitated and decaudated specimens were seen, and a few specimens killed by autos were observed. The specimens in this region appear to be distinctly dwarfed as compared with the Texas specimens, and may warrant a revival of Kennicott's "*sonoraensis*."

Most of the specimens were captured on the gravelly flats near the sea, and in the sand piled up by the waves where the sandy beach and shrub meet. This area harbors many rodents, insuring a constant food supply.

One specimen was captured at Hermosillo. These specimens have been studied by Mr. Howard K. Gloyd.

Crotalus molossus molossus Baird and Girard

Crotalus molossus Allen (Gloyd), Occ. Papers Mus. Zoöl. Univ. of Mich., No. 259, April 3, 1933, pp. 13-14.

Four specimens of this form were collected, one five miles southwest of Hermosillo, crawling at night among the boulders, and three near La Posa, ten miles northwest of Guaymas. One, an old, emaciated male, was taken late at night in a small cave in the mountains near La Posa. One was captured at 3:00 o'clock in the afternoon crawling along the west side of a cliff in a narrow shadow. The colors were very bright, as if it had recently shed. It did not sound

its rattles on my approach or even while being captured. A fourth was found early in the morning in another small cave near La Posa. This specimen was skeletonized.

Data on these specimens have been taken by Mr. Howard K. Gloyd.

Crotalus tigris Kennicott

Crotalus tigris Allen (Gloyd), Occ. Papers Mus. Zoöl. U. of Mich., No. 259, April 3, 1933, pp. 12-13.

One specimen (No. 154) collected five miles southwest of Hermosillo was found coiled at night near an isolated rock mass. As my light approached, the snake neither moved or rattled; in fact the rattles were not sounded until it was being carried in the sack.

A second specimen (No. 224) was found coiled at night in low mountains near La Posa.

These specimens have been studied by Mr. Howard K. Gloyd, who, presumably, will publish the scale data taken.

TURTLES

Kinosternon sonoriense Le Conte

Kinosternum sonoriense Le Conte, Proc. Acad. Nat. Sci. Phila., 1854, p. 184 (type description; type locality, Tucson, Ariz.).

Two specimens were taken, one consisting of a carapace and bones of a dead specimen found in a dry arroyo. Another specimen was captured in the highway, fifteen miles north of Hermosillo. (No. 1168.)

Gopherus agassizii (Cooper)

Xerobates agassizii Cooper, Proc. California Acad. Sci., II, 1863, p. 120 (type description; type locality, mountains near Fort Mojave, Calif.).

This species was rather common in Sonora. Four specimens were collected and several seen were not collected. Their usual hide-outs during the day were small excavations around the base of cliffs, and in the soft earth in old cliff caves.

I do not have material available from the type locality, so the association of these specimens with *agassizii* is done without due critical examination.

The specimens are: No. 115, 40 miles south of Noria, June 22, in a large rock crevice filled partly with refuse from a colony of leaf-cutting ants; Nos. 237 and 237a, at base of cliff near La Posa, June 29; No. 1167, twenty miles north of Noria, August 11, in road.

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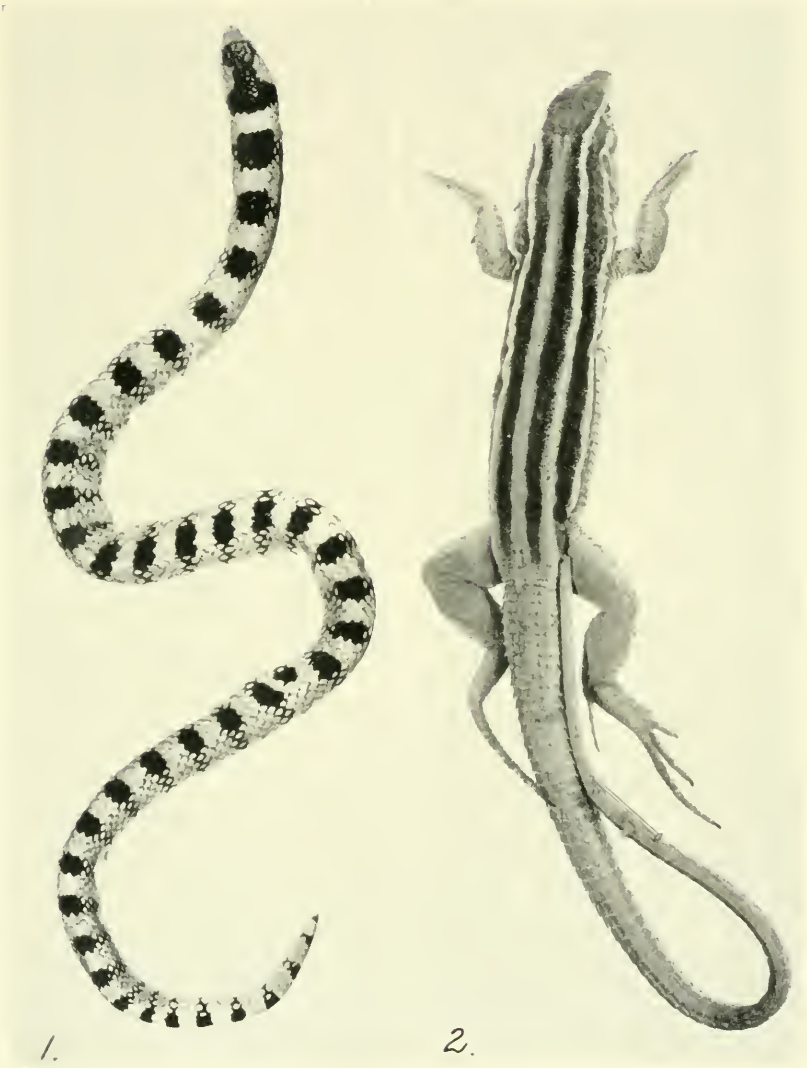
The following list from this work, which purports to be complete to date, 1922, gives the known species of the state of Sonora: *Coleonyx variegatus* (Baird) (San Miguel de Horcasitas; Tepoca Bay); *Dipsosaurus dorsalis dorsalis* (Baird and Girard) (northwestern Sonora); *Sauromalus townsendi* Dickerson (Tiburón Is.; Guaymas); *Crotaphytus collaris baileyi* (Stejneger) (Hermosillo; Sierra Tule; Tiburón Is.); *Crotaphytus wislizenii* Baird and Girard (northwestern Sonora; Tiburón Is.); *Uma notata* Baird (Tepoca Bay); *Callisaurus inusitatus* Dickerson (Tiburón Is.; Tepoca Bay; San Pedro Bay; Guaymas; San Miguel de Horcasitas); *Holbrookia maculata approximans* (Baird) (Duros Millos; headwaters of the San Pedro river); *Holbrookia elegans* Bocourt (Guaymas); *Holbrookia texana* (?Sonora); *Uta ornata lateralis* (Boulenger) (Guaymas; Tiburón Is.); *Uta ornata symmetrica* (Baird) (two miles south of Nogales; 32 miles south Nogales; Duros Millos); *Uta stansburiana elegans* (Yarrow) (Tepoca Bay; San Pedro Bay; Tiburón; Patos and Pelican Islands); *Sceloporus scalaris* Wiegmann (no localities given); *Sceloporus consobrinus* Baird and Girard ("Sonora," Cope); *Sceloporus jarrovii* Cope (Pinetos Camp, 32 miles south of Nogales); *Sceloporus torquatus poinsettii* (Baird and Girard) ("Sonora"); *Sceloporus magister* Hallowell (Tiburón Is.); *Sceloporus clarkii* Baird and Girard (32 miles south of Nogales; San Pedro Bay; Tiburón and San Pedro Nolasco Islands); *Phrynosoma douglassii hernandesi* Girard (northern Sonora); *Phrynosoma ditmarsi* Stejneger (Sonora, a short distance south of the border of Arizona); *Phrynosoma solare* Gray (Hermosillo); *Phrynosoma goodei* Stejneger (Gulf Coast of Sonora); *Phrynosoma m'callii* (Hallowell) (Sonora); *Phrynosoma modestum* Girard (Sierra de la Narizo); *Heloderma suspectum* Cope (Guadalupe Cañon; San Bernardino; Niggerhead Mountain; San Pedro Bay); *Gerrhonotus kingii* (Gray) ("Sonora," Cope); *Cnemidophorus gularis* Baird and Girard (2 miles south of Nogales; Pinetos Camp 32 miles south of Nogales; San Pedro Bay; Guaymas); *Cnemidophorus melanostethus* Cope (Hermosillo; Tepoca Bay; San Pedro Bay; Guaymas; Tiburón); *Siagonodon humilis* (Baird and Girard) (San Miguel de Horcasitas); *Constrictor imperator* (no locality given); *Diadophis regalis* Baird and Girard (San Magdalena); *Heterodon nasicus* Baird and Girard ("Sonora"); *Coluber flagellum piceus* (Cope) (Hermosillo; Tiburón Is.); *Coluber semilineatus* (Cope) (San Pedro Bay); *Salvadora hexalepis* (Cope) (Guaymas; Sierra Blanca; Tiburón Is.); *Lampropeltis getulus yumensis* Blanchard (Sonora); *Hypsiglena ochrorhynchus ochrorhynchus* Cope (Guaymas); *Thamnophis eques* (Reuss) (Guaymas); *Thamnophis marcianus* (Baird and Girard) (Sonora); *Sonora semiannulata* (Baird and Girard) (Sonora); *Chilomeniscus cinctus* Cope (Guaymas, type locality); *Oxybelis acuminatus* (Wied) (no definite locality given); *Trimorphodon lambda* Cope (Guaymas); *Micrurus euryxanthus* Kennicott (Sonora); *Hydrus platurus* (Linnaeus) (Pacific coast, Guaymas); *Kinosternon sonoriense* (Le Conte) (San Pedro river; Cajón Bonita creek; San Bernardino river; Guadalupe Cañon; *Gopherus agassizii* (Cooper) (Tiburón Is.; San Pedro Bay); *Dermochelys schlegelii* (Garman) (seen at Guaymas).

PLATE XLIII

FIG. 1. *Ficimia desertorum* Taylor. Photograph of type.
FIG. 2. *Cnemidophorus burti* sp. nov. Photograph of type.

PLATE XLIII



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Notes on the Herpetological Fauna of the Mexican State of Sinaloa

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ABSTRACT: The report is based upon a collection of reptiles and amphibians, now on deposit at the University of Kansas, secured by Edward H. Taylor in the southern part of Sinaloa, July 19 to 25, 1934. Two hundred and forty-one specimens were secured: Amphibians, 128 specimens, twelve species; lizards, 94 specimens, ten species; snakes, 16 specimens, seven species; turtles, three specimens, one species. A list is given of the species known from the state. *Bufo kelloggi*, sp. nov., is described from a locality near Mazatlán; and *Trimorphodon paucimaculatus*, sp. nov., is described from Mazatlán. A bibliography is appended.

THE basis for this report is a collection of reptiles and amphibians which I made in the southern part of Sinaloa during the summer of 1934. The period from July 19 to July 25 was spent in the region about Mazatlán and Presidio, and 241 specimens were collected. These are distributed as follows: Amphibia, 128 specimens, twelve species; lizards, 94 specimens, ten species; snakes, 16 specimens, seven species; turtles, three specimens, one species.

The following extracts from the field book show date and locality of the collections:

July 19. Journeyed by "autovia" to a point a few miles beyond Presidio, which is situated on the Río Mazatlán about fifty miles south of Mazatlán. Returned to Mazatlán at night. Terrain flat, with low forest.

July 20. Collected in the general area about two miles east of Mazatlán. A low rocky hill was visited. Rain pools in this same vicinity were visited at night.

July 21. Same as previous day.

July 22. No collecting.

July 23. Returned to Presidio and collected within a three-mile radius of the village.

July 24. Collected in the region about Mazatlán, visiting rain pools at night.

July 25. Collected during the morning in series of hills two to five miles east and southeast of the city. Departed for Nayarit in afternoon.

There were a few heavy rains during this time, making rather ideal conditions for collecting amphibians.

The hills near Mazatlán were low; none were visited that reached an elevation above three hundred feet. Consequently there was little variation in the general ecological associations. The rain-pool associations were of a temporary nature.

Sinaloa is a region of importance to students of animal distribution, as it is a boundary between two faunal regions. The fauna of the southern part differs to the extent of at least seventy percent from the fauna of Sonora, which lies to the north. There is no strongly defined dividing line crossing the state, since there is an intermingling of the two faunas through a rather wide area, and much more extensive collecting must needs be done before the limits even of individual species can be accurately determined.

The following species have been reported from Sinaloa. Almost without exception these records are from the southern part of the state in the region about Mazatlán and Presidio, Rosario and Plomosas. A few of the records are questioned.

AMPHIBIA

? *Leptodactylus melanonotus* (Hallowell)
Eleutherodactylus mexicanus (Brocchi)
Bufo simus Schmidt
Bufo marmoreus Wiegmann
Bufo debilis (= *Bufo kelloggi*, sp. nov.)
Pternohyla fodiens Boulenger
Diaglena spatulata Günther
Agalychnis dacnicolor Cope
Hyla arenicolor Cope
Hyla baudinii Duméril and Bibron
Hypopachus oxyrhinus Boulenger
Microhyla usta (Cope)
Rana forreri Boulenger (= ? *Rana pipiens* Schreber)

TURTLES

Emys ornata Gray
Emys pulcherrima Gray
Kinosternon hirtipes Wagler

CROCODILES

Crocodilus acutus Cuvier

LIZARDS

? *Sphaerodactylus torquatus* Strauch (probably introduced)
Phyllodactylus lanei Smith
? *Phyllodactylus tuberculosus* Wiegmann

Peropus mutilatus (Wiegmann). Introduced.
Coleonyx fasciatus (Boulenger)
Anolis nebulosus (Wiegmann)
Anolis utowanae Barbour
? *Callisaurus ventralis* Hallowell
Ctenosaura pectinata (Wiegmann)
Ctenosaura acanthura (Shaw)
Iguana rhinolopha Wiegmann
? *Holbrookia maculata approximans* Baird
? *Holbrookia propinqua* Baird and Girard
Holbrookia elegans elegans Bocourt
Uta ornata lateralis (Boulenger)
Uta bicarinata (A. Duméril)
Uta tuberculata Schmidt
Sceloporus nelsoni Cochran
Sceloporus clarkii boulengeri (Stejneger)
Heloderma horridum Wiegmann
? *Cnemidophorus sexlineatus* Linnaeus
Eumeces humilis Boulenger
Eumeces parvulus Taylor

SNAKES

Geophis rodimita Cope
Pseudoficimia frontalis Cope
Ficimia quadrangularis Günther
Rhinochilus antonii Dugès
Lampropeltis annulatus (Kennicott)
Drymarchon corais (Cuvier)
? *Masticophis flagellum flavigularis* (Hallowell)
Masticophis semilineatus (Cope)
Drymobius margaritiferus (Schlegel)
Leptophis diplotropis (Günther)
Natrix valida (Kennicott)
Hypsiglena torquata (Günther)
Tropidodipsas philippii (Jan)
Tantilla bimaculatum (Cope)
Leptodeira punctata (Peters)
Leptodeira maculata (Hallowell)
Trimorphodon bi-scutatus (Duméril and Bibron)
Oxybelis acuminatus (Wied)
Micrurus diastema distens (Kennicott)
Agkistrodon bilineatus (Günther)
Crotalus basiliscus (Cope)

The earliest collecting done in this region was previous to 1868, on which date a collection, made by Ferdinand Bishoff, was received at the Smithsonian Institution.

A notable collection was that of Alfonso Forrer, who collected at Presidio and Mazatlán about 1885. He obtained the types of several

forms of amphibians, including *Hypopachus oxyrhinus* Boulenger, *Rana forreri* Boulenger, *Pternohyla fodiens* Boulenger and *Diaglena spatulata* Günther, and numerous reptiles, including types of *Eumeces bocourti* (= *Eumeces humilis* Boulenger), *Uta lateralis* Boulenger, and *Ficimia quadrangularis* Günther.

A small collection was made by J. A. Kusche at "Venodia," Sinaloa, where he obtained a specimen of the rare *Diaglena* and other important specimens.

E. W. Nelson and Edward A. Goldman collected in Sinaloa during parts of 1897, 1898 and 1899. They journeyed through northern Sinaloa from Agiabampo to Culiacán, and from Altata across the state to Chacala, Durango. They also visited the southern part of the state, collecting at Mazatlán, Rosario and Plomosas. Numerous specimens were collected, including the types of *Sceloporus nelsoni* Cochran.

Paul D. R. Rüthling made a small collection at Mazatlán, in 1920.

AMPHIBIA

Scaphiopus couchii Baird

(Plate XLIV, figs. 1-4)

Nineteen specimens (Nos. 2902 to 2920) of this species were collected on a hill about two miles east of Mazatlán. They were found at night along a path leading up to a deserted gold mine. Kellogg (*loc. cit.*) has reported this species from Acaponeta, Nayarit, about ninety miles to the south of Mazatlán. These specimens appear to be the first record for Sinaloa.

These specimens appear to differ from the typical form in having the skin of the occipital and interorbital region almost completely involved in the ossification of the skull, despite the fact that none appear to be full grown. There are certain other differences such as the width of the "shovel" metatarsal tubercle, the larger size of the eye and the greater width of the skull in specimens of equal snout-to-vent length.

Bufo marinus Linnaeus

A single specimen (No. 951) was routed from under a log of driftwood in the sandy bed of the Mazatlán river at Presidio. It has not previously been reported in Sinaloa, but Kellogg has reported a specimen from Camoa, Sonora, far to the north.

Bufo punctatus Baird and Girard

A single specimen (No. 131) was collected under a rock at the top of a small hill about three miles southeast of Mazatlán. It agrees

with specimens from Sonora and Arizona in color and markings, as well as in most structural characters. Although a small specimen, the supraorbital crests are more strongly developed and the parotoid glands are very much larger (nearly double). The ventral surface has numerous black dots on anterior half.

This is apparently the southernmost point in western Mexico where the species has been found. It has not hitherto been reported from the state of Sinaloa.

Bufo valliceps Wiegmann

Seven specimens of a toad (Nos. 373-379) found two miles east of Mazatlán have been tentatively referred to this species. There are, however, differences evident when compared with typical *valliceps* from Oaxaca and Guerrero.

The cranial crests are high, relatively narrow, and edged with black. The tympanum is large, equalling more than half the diameter of the eye. The subocular crest is obsolete or represented only by a few tubercles. The first finger is longer than the second. There is a slight fold or ridge on snout from lip to between nostrils; there is only a faint suggestion of a parietal crest.

The measurements show that these specimens are larger than typical *valliceps*, and may belong to the form briefly described by Cope as *Bufo argillaceus*.*

Measurements (in mm.) of *Bufo valliceps* Wiegmann

Number	373	379	374	375
Sex	♀	♀	♀	♀
Snout to vent	86	83	85	63
Length of head to posterior edge of tympanum	24	24	24	22
Width of head, greatest	29	30	29	25
Width interorbital crests	8	9	8.5	7.5
Width upper eyelid	7	7	6.6	5
Foreleg	50	48	48	37
First finger	8.1	8	8.6	6.5
Second finger	7	7	7	5.8
Hind leg (from anus)	95	92	95	77
Tibia	30	30.5	28.5	22
Foot (to tip of longest toe)	46	41	44	32

* Proc. Acad. Nat. Sci. Phila. 20, 1868, p. 138. This form is regarded as a synonym of *marmoreus* by Kellogg (1932), who had the types available for study.

I have as yet not compared these specimens with the type. It is probable that if this were done other differences would appear which, together with those mentioned, might warrant giving a specific name to this form.

Bufo kelloggi sp. nov.

(Plate XLV, figs. 1-3)

Holotype. No. 21, EHT & HMS Collection. Two miles east of Mazatlán, Sinaloa, July 21, 1934, E. H. Taylor, collector. *Paratypes,* Nos. 15 to 20, and 22 to 40, Mazatlán, Sinaloa, July 20-21, 1934, E. H. Taylor, collector.

Diagnosis. A small species related to *Bufo insidior* and *Bufo debilis,* but differing in having rather well-developed supraocular, preocular, postocular, subocular, and canthal crests, all surmounted by conical tubercles, each terminating in a sharp spine; interorbital space strongly concave, becoming more shallow in the intercanthal region; loreal region nearly vertical; the inner palmar tubercle not as large as a subarticular tubercle; median palmar tubercle round, subglobular; parotoid gland large, but low and inconspicuous, broad as long, extending as low on the side of neck as the angle of the jaws, heavily studded with spines. Entire dorsal and lateral surfaces of body and limbs studded with large conical tubercles, terminating in one or more brown-tipped spines.

Description of the type. Snout seen from above narrow, short, sharply truncate, the canthi with sharp canthal ridges surmounted by pointed tubercles, the area between forming a V-shaped trough; nostrils lateral, very near the extreme anterior tip of snout; loreal region sloping slightly, slightly concave between nostril and eye; the suborbital ridge continued more or less distinctly to below nostril (sometimes tending to connect by a row of tubercles with the continuation of the canthal ridge in front of the nostril); from a dorsal view the edges of jaws are not visible; the supraorbital ridge semicircular, continuous with a very strong preocular crest which is nearly vertical, but does not reach the subocular crest; postocular crest not always well developed, while the supratympanic crest is not or barely defined; tympanum moderately distinct, its vertical diameter about one third the longitudinal diameter of the orbit; length of snout from in front of eye about three fifths of the length of the orbit; width of upper eyelid about three fourths the narrowest distance between the supraocular crests; interorbital and intercanthal region concave, with spiny tubercles, the area between

the junction of the supraorbital and canthal crests somewhat inflated; lower edge of the upper lip with a series of small, low tubercles forming a slight ridge; in lateral profile the snout projects much beyond the mouth and slopes back from the tip to the mouth rather gradually; the ventral outline of the upper jaw is distinctly not circular—the sides if projected would form a right angle.

Tongue narrow, elongate, rounded but not nicked behind; choanae large, separated by a distance of little less than distance between nostrils, partly concealed by the overhanging jaw (male with a median vocal pouch).

The parotoid gland is large but not strongly salient, attaining its greatest width very near its most anterior point, the dorsal border only slightly notched.

Body covered with prominent spinose tubercles on dorsal and lateral surfaces, smaller on latero-ventral abdominal surface, becoming still smaller medially; on breast the tubercles are more prominent, each with a distinct spine. Limbs, save in postfemoral and posthumeral regions, strongly spinose; first finger slightly shorter than second; inner palmar tubercle small, no larger than the subarticular tubercles; hind leg short, the tibiotarsal articulation not or barely reaching axilla; legs folded at right angles to body, the heels narrowly fail to touch; femur involved in the body skin nearly two thirds of its length; toes about one third to two fifths webbed; two small metatarsal tubercles.

Color in life. Above yellowish-brown with numerous blackish-brown markings, sometimes tending to form elongate spots; an irregular, light yellowish-brown stripe from labial border to groin, more or less interrupted in parotoid region; legs and arms marked with heavy bars, continuous when limb is folded; foot strongly spotted; below dull brownish-yellow with scattered spots of blackish on the lateral abdominal region and across the pectoral region; chin immaculate yellowish (in males the chin is dark grayish to blackish).

Measurements (in mm.) of *Bufo kelloggi* sp. nov.

Number	21	28	20	41	40	24	37	38	27	22	35
Sex	♀	♀	♀	♀	♀	♀	♀	♂	♂	♂	♂
Snout to vent	43	44	42	41	40	42	41	37	36	37	38
Width of head at tympanum	16	15.5	15	14.5	14.3	16	15	13	14.2	16	15.2
Length of head from posterior edge of tympanum	11	10.8	10.6	10	9	11.6	10.2	9.5	10	9.8	9.2
Diameter of orbit from pre- to postorbital crests	5.3	5.5	5.6	5	5.2	5	4.8	4.7	4.8	4.9	5
Snout from preorbital crest	3.3	3.1	3.2	2.5	3	3.8	3.5	3.1	2.9	2.8	3.2
Interorbital width from top of crests	4.2	4.2	4	4	.....	3.8	3.5	3.6	3.4	3	3.5
Eyelid	3.3	3.7	3.8	3.4	.....	3.2	3.4	3.2	3.1	3	3
Foreleg	22	21.5	22.3	21	.....	22.5	21	17.5	19	21	19
First finger	2.9	3	3.5	2.5	.....	2.8	2.8	2.1	2.5	2.7	2.1
Second finger	3.1	3.2	3.6	3.1	.....	3.2	3.2	2.3	2.7	3	2.3
Hind leg from anus	47	46	47.2	45	.....	46	45	39	40	40.2	38
Tibia	15	15	15	14	.....	15	14	13	13	13.2	12
Foot	22	21.6	22	21	.....	21	22	18	18.6	19	21

Variation. The large series displays a remarkable constancy in color markings, body proportions and the general character of the crests and spiny tubercles. There seems to be some variation in the length of the first two fingers; usually the second is a little longer, but occasionally they are very nearly the same length in some younger specimens.

Relationship. This small toad is most closely related to *Bufo debilis* and *Bufo insidior* Girard. From *Bufo debilis* (Eastern Texas and Tamaulipas) the present species differs in having a slightly larger orbital diameter; in having the cranial crests better developed and studded with sharply pointed tubercles; in having a shorter leg, the tibio-tarsal articulation reaching only to axilla; in having better developed spiny tubercles on the dorsal, lateral and ventral surfaces of the body; a less prominent, somewhat differently shaped parotoid; the interorbital width distinctly less; and in a totally different color pattern. (See plate XLV, figs. 4-6.)

From *Bufo insidior* Girard (Kansas, Texas, New Mexico, Chihuahua, Durango and Zacatecas) it differs in the presence of the cranial crests (lacking or with only an occasional faint trace of crests in *insidior*) in having shorter hind legs, a shorter snout, larger eye, narrower head and narrower interorbital width, a differently shaped parotoid and a totally different dorsal color pattern. It has very much larger and more numerous spiny tubercles on dorsal and lateral surfaces; the inner palmar tubercle is less developed, as are the metatarsal tubercles; the webbing between the toes is slightly more extensive. The color pattern is entirely different. (See plate XLV, figs. 7-9.)

Remarks. The specimens were collected in the daytime under rocks and logs, and at night hopping about on a small flat near a rain pool only a few hundred meters from a tidewater bay. They were not heard calling.

The revival of the name *insidior* for the small toad occupying a very extensive territory extending from Kansas south through New Mexico, Oklahoma, Texas, Coahuila, Chihuahua, Durango and Zacatecas is, I believe, wholly warranted. Specimens from Kansas have the same characteristics, including almost the same identical color pattern as those from the southern part of the range in Zacatecas. Large series are at hand for comparison.

The species is named for Dr. Remington Kellogg of the United States National Museum, whose excellent work, "Mexican Tailless Amphibia," appeared in 1932.

Leptodactylus occidentalis Taylor

Leptodactylus occidentalis Taylor. Trans. Kansas Acad. Sci., 39, 1936, pp. 349-352.

Three specimens of this species were collected near Mazatlán. One had been swallowed and partially digested by a snake, *Leptoderia personata* (No. 566). These specimens agree with typical specimens from Tepic, Nayarit, from which locality the species has recently been described.

Pternohyla fodiens Boulenger

Pternohyla fodiens Boulenger, Ann. Mag. Nat. Hist., Ser. 5, X, No. 58, 1882, pp. 326, 327. (Type description; type locality, Presidio, fifty miles from Mazatlán, Sinaloa; Forrer, collector.)

A series of fourteen specimens, Nos. 1368-1381, were collected about two miles east of Mazatlán. The specimens were hopping about in the fields, usually not far from rain pools. They were very wary and the approach of my light was a signal for them to make for thick clumps of shrubbery where they were safe. Only very alert action on my part prevented the escape of the specimens taken. All are quite typical.

Kellogg reports the species from Mazatlán and Rosario in Sinaloa.

Diaglena spatulata (Günther)

Two specimens (Nos. 1423, 1424) of this rare species were collected a few miles to the south of Presidio, which is the type locality. Kellogg (*loc. cit.*) was able to discover only four specimens in collections; the three cotypes from Presidio, and a fourth specimen from "Venodio," * Sinaloa.

Thus the known distribution is in a very restricted district in southern Sinaloa.

Intensive collecting in Nayarit by H. M. Smith and myself, and in Colima by Smith, failed to discover the species in these localities. My Presidio specimens were taken under a small piece of a log on the edge of a shallow stagnant pool. Both were crouched together, and when picked up they remained motionless. The axis of the head was turned nearly at right angles to the body. Whether this is indicative of a phragmotic habit as suggested by Barbour† for

* I suspect that this should be Venadillo (pronounced somewhat like "Venodio," which name is not listed in the Directorio General de Correos, but which does list Venadillo, Mazatlán, Sinaloa).

† Barbour, Reptiles and Amphibians, their habits and adaptations. Houghton Mifflin Co., Boston and New York, 1926. p. 74.

certain related genera, I cannot say. J. Aug. Kusche, who collected a specimen (No. 73266 U. S. N. M.), recorded that it was collected in a termite nest in a tree.

Both of my specimens are males. One, obviously, had been calling the previous night, as the vocal sac was much distended and folded. In the other the throat showed no external evidence of a sac.

The contents of the stomachs were examined. In one there was a single small beetle; in the other were found one beetle and fragments of a blattid. In the mouth were four, rather large, brown ants.

The eyes of this form appear peculiar in that the eyeball appears to be directed somewhat forward rather than laterally. Both of these specimens have the eye so turned, and Günther's figure shows somewhat this same condition. I failed to observe the eye in the living specimens.

The measurements of Nos. 1424 and 1423 are, respectively (in millimeters): Snout to vent, 74, 71; length of casque, 29, 27.5; width at eyes, 22, 19; length of arm, 37.5, 36; length of legs, 87-86, 81-83; tibia, 28, 27; foot, 37, 35; diameter of tympanum, 3, 3; diameter of eye, 7.5, 6; length of third finger, 19, 18.

Agalychnis dacnicolor Cope

Phyllomedusa dacnicolor Kellogg, Bull. U. S. Nat. Mus., No. 160, 1932, pp. 143-144.

A series of twenty-nine specimens (Nos. 1306-1334, July 21-24) was collected in the general vicinity of Mazatlán, for the most part one to two miles east of the city. All were found in shrubbery or trees near rain pools. All the specimens were grass-green in life, often tending toward bluish-green. When preserved most of them changed to a bluish or violet shade. Eggs were found and pairs were found clasping. They did not appear to be afraid of the light, and were easily collected.

Kellogg reports the species from Rosario, Presidio and Mazatlán in Southern Sinaloa.

Hyla baudinii Duméril and Bibron

Hyla baudinii Kellogg, Bull. U. S. N. M. No. 160, 1932, pp. 160-163.

A single specimen (No. 658) was taken from the throat of *Masticophis lineatus* collected two miles north of Presidio. The frog had apparently been hidden among the dead leaves of a palm tree, from which I shot the snake. The frog is a large female measuring 75 mm. snout to vent. The tibiotarsal articulation reaches the eye. The sides are reticulated with brown, enclosing yellowish spots. The

posterior femoral region displays a darker reticulation enclosing lighter yellowish spots. Kellogg reports specimens from "north of Mazatlán" (1) and Plumosas (2).

Hyla smithii Boulenger

Hyla smithii Taylor, Trans. Kans. Acad. Sci. XXXIX, 1936.

A single specimen (No. 2174) was taken on a floating plant in a rain pool about two miles east of Mazatlán. About this same pool were found *Pternohyla fodiens, Agalychnis dacnicolor, Microhyla olivacea, Bufo kelloggi* and *Bufo valliceps.* Others were heard calling. The specimen in life was canary to lemon-yellow with a few darker dorsal spots among the very numerous minute dark flecks (under the microscope many of the minute spots are star-shaped). The specimen is an adult male with the vomerine teeth well developed. Snout to vent, 22 mm.

Microhyla olivacea (Hallowell)

Engystoma olivaceum Hallowell, Proc. Acad. Nat. Sci. Phila., 1857, p. 252. (Type description; type locality "Kansas and Nebraska.")
Gastrophryne olivacea Smith, Amer. Mid. Nat., XV, 1934, No. 4, pp. 501-505.

I have tentatively associated with this species three small microhylids (Nos. 1236 to 1238) collected about two miles east of Mazatlán under rocks at the base of a small clay hill. When compared with Texas specimens of equal size they differ in having a narrower head, the snout a little more projecting and more flattened. They are somewhat darker and on the side, from snout to groin, the pigment tends to form a darker broken line. There is a slight difference in the shape of the foot and the metatarsal tubercle is slightly more salient. They differ somewhat less from a series of specimens collected by Hobart Smith and David Dunkle at Conejos, Durango. None of the three specimens approaches the maximum size of *olivacea.* A larger, more representative series may demonstrate that these and perchance other characters warrant a specific designation for the coastal form. If properly associated with *olivacea* these records extend the known range some 200 miles farther to the southwest.

Rana pipiens Schreber

Four specimens were collected: No. 2926, three miles east Mazatlán, July 20; 2927-2928 near Presidio, July 24; 2929 near Mazatlán, July 25. No. 2926 is a female measuring 125 mm. snout to vent. The ovaries are packed with ripe eggs. Kellogg (*op. cit.*) reports specimens from several localities in Sinaloa.

Phyllodactylus lanei Smith

Phyllodactylus lanei Smith, Univ. Kansas Sci. Bull., XXII, April 15, 1935, pp. 125-132, plate XXV, fig. 3 (photograph of type). (Type description; type locality, Tierra Colorada, Guerrero. E. H. Taylor and H. M. Smith, collectors.)

Three specimens (Nos. 534, 535, and 704, July 21-24, 1934) were collected about two miles east of Mazatlán, Sinaloa. H. Smith has studied these specimens and has referred them to this species. All are immature, but they agree well with juveniles of the series from Guerrero.

Coleonyx fasciatus (Boulenger)

(Plate XLVI, fig. 2)

Eublepharis fasciatus Boulenger, Cat. Liz. Brit. Mus., 2d Ed., 1, 1885, p. 234. (Type description; type locality "Ventanas [Durango]; A. Forrer, collector); Günther, Biologia Centrali-Americana Reptilia and Batrachia, April, 1893, p. 84, pl. xxxi, fig. a (entire animal natural size and head).

Coleonyx fasciatus Taylor, Univ. Kans. Sci. Bull., XXII, Apr. 15, 1935, pp. 203-205.

Elsewhere (*loc. cit.*) I have reported on this specimen collected about ten miles south of Presidio, Sinaloa, June 19, 1934. It has the following measurements: Snout to vent, 59 mm.; tail, regenerated, 53 mm.; width of head, 10 mm.; head length, to angle of jaw, 15 mm.; foreleg, 17 mm.; hind leg, 22.5 mm.

Ctenosaura pectinata (Wiegmann)

Ctenosaura pectinata Bailey, Proc. U. S. Nat. Mus., 73, 1928, pp. 24-27; Smith, Univ. Kansas Sci. Bull., XXII, April 15, 1935, pp. 134-137.

The following specimens were taken: Nos. 525-527 ten miles south of Presidio, July 19; No. 583 near Mazatlán, July 20, and Nos. 654-656 near Presidio, July 21.

Smith (*loc. cit.*) discusses these specimens.

Iguana rhinolopha Wiegmann

Iguana rhinolopha Smith, Univ. Kansas Sci. Bull., XXII, April 15, 1935, pp. 134-137.

Four specimens, Nos. 650-653, were collected at Presidio, on the edge of the Rio Mazatlán, July 22, 1934.

Smith (*loc. cit.*) reports on these specimens.

Holbrookia elegans elegans Bocourt

Holbrookia elegans Bocourt, Miss. Sci. au Mexique; Rept. Batr., Liv. 3, 1874, pl. XVII bis, fig. 8, 8a, dorsal and ventral view of head. (Type description; type locality Mazatlán, Sinaloa.)

Holbrookia elegans elegans Smith, Univ. Kansas Sci. Bull., XXII, April 15, 1935, pp. 191, 194, pl. XXVII, fig. 2 (photograph dorsal view), and XXVIII, fig. 5 (femoral pores).

A series of six specimens, Nos. 643-648, were taken near Presidio, Mazatlán, Sinaloa, July 22, 1934.

Smith (*loc. cit.*) has commented on this series.

Uta tuberculata Schmidt

Uta tuberculata Schmidt, Amer. Mus. Nov., No. 22, 1921, p. 4. (Type description; type locality, Colima, state of Colima, Mexico; Rüthling, collector.) Smith, Univ. Kan. Sci. Bull., XXII, April 15, 1935, pp. 171-172, pl. XXVI, fig. 1 (photograph of E. H. T. Collection, No. 552, male).

A single specimen, No. 552, was collected about fifteen miles south of Presidio, Mazatlán, Sinaloa. Smith (*loc. cit.*) has reported on this specimen.

Anolis nebulosus (Wiegmann)

Three specimens, Nos. 553, 554, taken near Presidio, and No. 761, near Mazatlán, are referred to this species.

Body slightly compressed, the forehead concave; supraorbitals are in contact and continued forward as two divergent frontal series, but not forming a frontal keel; normally three supraoculars separated from the supraorbitals by a row of granular scales; four rows of loreals; four canthals; a slight nuchal crest; occipital large, very much larger than auricular opening; six or seven labials to below middle of eye; gulars slightly keeled; ventrals keeled, slightly smaller than the dorsals which pass rather gradually into the granular lateral scales; enlarged postanals; fourteen scales under the second and third phalanges of fourth toe; gular appendage large, reaching beyond the thorax, grayish or with a pinkish tinge. Markings very indistinct save that radiating lines about the eye are evident.

Sceloporus nelsoni Cochran

Sceloporus nelsoni Cochran, Jour. Washington Acad. Sci. XIII, 1923, May 4, pp. 185-186. (Type description; type locality, Plomosas, Sinoloa, Mexico. Nelson and Goldman, collectors.)

The following specimens collected in Sinaloa are referred to this species: Nos. 577, 578 about two miles east of Mazatlán, July 20, 1934; Nos. 755-760 about four miles southeast of Mazatlán, July 25, 1934.

The relationship of this form is obviously with *pyrocephalus,* but the differences pointed out by Doctor Cochran, while small, are numerous and certain of them rather constant.

The males of my series have, usually, a well-defined black shoulder spot extending somewhat on the arm, while on the breast on either side is an orange or brick-red spot touching the black spot and partially surrounded by darker color. The anterior part of the abdomen is whitish or yellowish. The chin is whitish and bluish-gray, the white forming a number of converging narrow lines usually continuous with lines extended across labials and side of head. These lines are narrower and more numerous than those in *pyro-*

cephalus. The belly is black medially, bordered by bluish color on each side, this fading to dim yellowish-brown which appears lavender in preserved specimens; a darker lateral band with a few yellowish flecks usually present. The femoral pores vary between 15 and 18, 16 and 17 occurring most frequently.

The dorsal color is grayish-brown, with two olive, dorsolateral lines, the edges of which are not clearly defined; tail with fourteen narrow light annulations, immediately in front of which the ground color is darker than remaining interspace; a dark light-ringed spot on posterior part of occipital scale.

Females are grayish-brown, the dorsolateral stripes scarcely or not discernible and with small, paired, indefinite, dark spots present; belly immaculate whitish (of a greenish cast in one); chin less distinctly striped, the dark shoulder spot and the orange breast spot less distinct than in males (or obsolete). The tail is much more strongly banded, the whitish or cream rings widening dorsally.

Sceloporus utiformis Cope

Sceloporus utiformis Cope, Proc. Acad. Nat. Sci. Phila., 1864, pp. 177. (Type description; type locality Colima, Colima, Mexico); Bocourt, Miss. Sci. au Mexique; Rept. Batr., Liv. 4, 1874, pp. 208-210, pl. XVIII bis. fig. 6, 6a, 6b (dorsal view of head, detail of ear, and dorsal scale) (Colima).

A single specimen (No. 555) of this very well-defined species was taken about twelve miles south of Presidio, July 19, 1934. The specimen was discovered in the bed of a dry creek and was the only one seen during my two days collecting near Presidio.

Compared with Cope's type description the number of femoral pores is larger, 16-17 in this specimen while the type has but 13. The description states, "Ten longitudinal rows of large, highly keeled, shortly mucronate dorsal scales, separated by many lateral series of minute flat scales, from the smaller entire edged abdominals." This specimen has approximately eight rows on the neck, ten on the posterior part of the body, while near the middle there are fourteen rows, the large scales pushing down on the sides. It is probable that this condition may also obtain in the type.

The ear opening is very large and the tympanum relatively superficial; the lateral nuchal pocket is especially deep, and the preauricular lobules much reduced. The head scales are distinctly rugose.

Strongly reddish-brown above, with ten narrow, irregular transverse dark bands, edged posteriorly with greenish or yellowish-white, the light edging formed by small white spots that are not continuous; this light color appears on the sides as numerous irregular white flecks each involving several granular scales. The tail is completely

encircled by brownish bands four scales wide, separated by wider lighter bands; head variegated brown. Upper labials traversed by six greenish-white, vertical stripes which continue on the throat and chin, those below eye strongest and separated by deeper brown interspaces. Limbs barred with wide dark and narrow greenish or yellowish-white bands. Throat gray, reticulated with white; belly and under side of limbs dirty white.

Sceloporus clarkii boulengeri (Stejneger)

Sceloporus boulengeri Stejneger, North Amer. Fauna, No. 7, May 1, 1893, p. 180, pl. 1, fig. 5a-c. (Type description; type locality, Presidio, fifty miles from Mazatlán, Sin. Forrer, collector.)

Sceloporus clarkii boulengeri Burt, Trans. Micros. Soc., Vol. LIV, No. 2, April 1935, pp. 171, 172 (part) (confuses *S. horridus oligoporus* and *S. melanorhinus* with *boulengeri*).

The following specimens were obtained: Nos. 528-534 ten miles south of Presidio (sixty miles south of Mazatlán), July 19; No. 587, two miles east of Mazatlán, July 21; Nos. 667-669 (skeletons) and 670-683 about two miles north of Presidio, July 23.

The specimens of this series, with the exception of No. 587, are topotypes. The femoral pores in twenty specimens (40 counts) have the following frequency: 8 occurs seven times; 9, seventeen times; 10, fourteen times and 11 twice, or an average of 9.02. Burt's (*loc. cit.*) comments on the femoral pores are due to his confusion of *Sceloporus horridus oligoporus* (Cope) (Klauber No. 7335 Zihuatenejo, Guerrero, with two femoral pores) and *Sceloporus melanorhinus* (Klauber No. 7336 Zihuatenejo, Guerrero, with twenty-one femoral pores, and No. 10153 Petatlan, Guerrero, with a high number of pores). The femoral pores are not more variable in *Sceloporus* than in other forms.

All the specimens were shot from large trees that stood isolated in pasture fields. Each of these scattered trees harbored rather large colonies. Very large series could have been taken had I so desired, as many specimens were left unmolested.

Cnemidophorus sacki Wiegmann

Cnemidophorus scxlineatus gularis Burt, U. S. Nat. Mus. Bull., No. 154, 1931, pp. 97-122 (part).

Cnemidophorus scxlineatus sackii Burt, Proc. Biol. Soc. Wash., 44, June 29, 1931, pp. 73-78.

In endeavoring to determine the proper name for the *Cnemidophorus* from southern Sinaloa, I have found it necessary to review the specimens of *Cnemidophorus gularis* and *Cnemidophorus sexlineatus* in the collections of Kansas University (about 200 of the former and 500 of the latter) and especially specimens from Texas and

Oklahoma, where the ranges occupied by these species overlap a known distance of more than five hundred miles. Special attention was given those specimens from Oklahoma and Texas with a view of discovering intergradation between these forms, a condition which I had not observed during extensive collecting in Texas. I have had available about 200 specimens from these states. I am wholly unable to discern intergradation in the pertinent characters (which may be used to separate the species) that suggests in any way a crossing of these species.

There obtains in adults of both *sexlineatus* and *gularis* strong sexual dimorphism in color and markings. The male *sexlineatus* has the ventral surface colored a very light blue in life, the color not or but slightly more intense on the throat; however, this blue color is lost in preservation and various changes result, depending upon the preservative used. The throat usually becomes a different shade of blue and the abdomen seems to be darker blue on the sides. In formalin the throat may become blackish and the abdomen likewise. The females of this form are rather creamy yellow ventrally, which color remains or becomes whitish in alcohol. In formalin the sides of the abdomen are a little darker. The maximum size in Texas and Oklahoma probably rarely exceeds 75 mm. snout to vent.

The *gularis* of this region have a strongly-defined pinkish to reddish-pink coloration on chin and throat often extending to the enlarged scutes on the breast; the ventral surface of the body of adult males is dark blue-black anteriorly, becoming somewhat bluish posteriorly, and with white, cream or bluish-white spots present, especially on the outer part of abdomen. Undersides of the hind limbs (partially), anal region and often the underside of tail are immaculate cream.

The females, however, are without either the pink throats or bluish bellies and as such are very often confused with *sexlineatus*. Data from these misidentified females taken with data from *sexlineatus* bring about a disheartening confusion which suggests intergradation.

While it is not certain, it seems highly probable that Burt (*loc. cit.*, 1931) has confused the females of *gularis* with both sexes of *sexlinatus*, since he does not note this sexual dimorphism.

He states (p. 83): "At the point of intergradation with *gularis* there is a complete transition from the characteristic granules on the post-antebrachium of *sexlineatus* to the larger, better developed, polygons that are usually found in that form" (*gularis*). This statement is wholly true when applied to series containing both the

ventrally unmarked females of *gularis* and males and females of *sexlineatus,* and is not true when applied to *sexlineatus* males or females of the material available in the Kansas University collections.

In consequence, I believe that *gularis* should not be associated with *sexlineatus* as a subspecies as Bocourt proposes (Mission Sci. Mexique 1874), Cope (1900) and followed by Burt (1931). The application of the name *C. sexlineatus* I believe should be limited to the small *Cnemidophorus* described by Linnaeus, occupying territory over a wide area in the eastern and central United States and as far west as Texas, Oklahoma, Kansas, Colorado and New Mexico. It may occur in northern Mexico.

The cnemidophori obtained in Sinaloa include the following: Nos. 535-551, ten miles south of Presidio, July 19; 581, 588-590, along edge of tide flats near Mazatlán, July 20 and 21; 684-688, in the vicinity of Presidio, July 23; 750-754, near Mazatlán, July 24.

It is with some hesitancy that I am associating the above name with the present species. Burt (Proc. Biol. Soc. Wash., Vol. 44, June 29, 1931, pp. 73-78) has recently published additional details of the type of *C. sacki* which Parker had observed on the type. These details apply to certain of the specimens before me. If these are not typical they would certainly have a subspecific relationship with *sacki.*

The specimens present the following characters: A six-lined form, the lateral line extending to the tip of the snout, crossing the suboculars, passing above the ear and terminating in the groin. The dorsolateral line arises at the last superciliary and continues a considerable distance on the tail. The dorsal lines are less distinct and are separated by a ground color much lighter than the dark-brown color between the other lines. There are small dots between the lateral and dorsolateral lines, males and females showing little or no sexual dimorphism. In larger specimens the lines break up into series of white dots which with the intervening dots tend to form light, broken, transverse bands. In still older specimens the area occupied by the longitudinal lines in the younger specimens now appears as the ground color, with a tendency to form interrupted dark transverse bands. The ventral surface of chin and throat is bluish-gray in adult males and females, rarely with a trace of pinkish. The bellies are deep blue-black with numerous bluish-white spots. The tail beneath has some bluish or blackish spotting.

The specimens from the tidewater flats have somewhat less dark

color below, but it is strongly evident on the sides. The dorsal linear markings do not break up into dots; the upper surface of the hind limbs are uniformly colored. The numerous spots on the Presidio specimens are lacking. The anterior continuation of the lateral line across the loreal region is strongly pronounced in young and old. The chin and throats are more strongly contrasting black and yellow. The enlarged scales on the gular fold are yellow-cream in all.

The largest size noted in the series is 119 mm. snout to vent, while several specimens measure 110 mm. or more.

Measurements (in mm.) and scale counts of *Cnemidophorus sacki* Wiegmann

Number, E. H. T. Collection	540	536	539	535	589	548	541
Snout to vent	119	114	110	110	110	108	105
Snout to occiput	28	24	28	24	24	23	23.5
Snout to ear	30	25.5	28	26	25	24	25
Breadth of head	21	20	20	18	20	15	17
Interorbital width	13	11.2	12	11	12	10	11
Hind leg	76	76	77	73	72	74	74
Tibia	25	24	25	22	21	23	23
Fourth toe	25	25	27	25	22	26	25
Lamellae, fourth toe	34	34	29	31	34	35	31
Femoral pores	20, 22	20, 21	20, 20	18,19	20, 21	18, 19	17,17
Dorsal scale rows	113	118	89	107	100	91	105
Ventrals (long)	36	37	33	35	34	35	36

Constrictor constrictor imperator (Linnaeus)

Two specimens were taken: No. 691, near Presidio, and No. 711, two miles east of Mazatlán. The latter specimen is alive at this date in the laboratory of zoölogy at University of Kansas.

Masticophis semilineatus (Cope)

Bascanium semilineatum Cope, Proc. U. S. Nat. Mus., XIV, pp. 622, 626. Type description; type locality Colorado river bottom. Schott, collector.

A large specimen of this species was collected about two miles east of Mazatlán, July 20. It was observed crawling in sparse brush, and when sighting me, it stopped, reared its head and remained motionless for some time. Certain other specimens seen, apparently of this species, escaped in brushy ground.

Ortenburger (1928) cites previous records for Mazatlán by Van Denburgh (1897), and for Presidio by Günther (1894).

My specimen, a male, presents the following characters: Ventrals, 192; caudals, 109+; scale formula, 19-17-17-13-13; upper labials, 8-8; lower labials, 9-10; preoculars, 2-2, touching frontal; postoculars, 2-2; temporals, 2+2+3+2; loreal, 1-1 (fused partially with preocular); head length to jaw angle, 42 mm.; to end of parietals, 33 mm.; supraorbital width, 15 mm.; total length, 1685+ mm.; tail 470+ mm.; maxillary teeth, 20-20; mandibular, 21-22; nasal divided; frontal equal to distance to end of snout; eye diameter reaches edge of posterior nasal.

In general, the color is typical. The ventrals have series of punctate spots bordering their edges, absent from a few. On the chin and throat the spots are much larger and darker.

Masticophis lineatus (Bocourt)

Bascanion lineatum Bocourt, Miss. Sci. au Mexique, Rept., Liv. 12, 1890, pp. 697, and 700-701, pl. XLVIII, fig., 1, 1a, 1b, 1c. (Type description; type locality, "Mexico." Collectors, Alfredo Dugès and Boucard.)

Masticophis lineatus Ortenburger, Mem. Univ. Michigan Mus., I, 1928, pp. 134-138, pl. XXV, figs. 3, 4, 5.

This little-known form is represented by three specimens, collected July 23 at a small pool beside the railway, about one mile north of Presidio (fifty miles south of Mazatlán). A fourth specimen, collected at the same time, escaped from my hotel room in Mazatlán when I was preparing to preserve it, and was crushed in the street a few moments later. It was not preserved. No. 663 was found in a tree swallowing a specimen of *Hyla baudinii*. The frog was recovered alive.

The three specimens, Nos. 662 ♀, 663 ♂, 664 ♂, present the following characters, respectively: Ventrals, 184, 184, 185; subcaudals, ?, 112, 120; upper labials, 8-8, 8-8, 8-8; lower labials, 10-11, 10-10, 10-10; preoculars, 2-2, 2-2, 2-2 (the large upper scale of each snake shows a strong suture partially dividing the scale); postoculars, 2-2, 2-2, 2-2; scale formulae, 20-17-17-13-13, 19-17-17-13-13, 19-17-17-13-13; mandibular teeth, 18-19, 18-18, 18-18; maxillary teeth, 18-18, 18-19, 18-18; head length to angle of jaw, 42, 42, 40 mm.; length to end of parietal, 28, 30.5, 27.5 mm.; interorbital width, 14, 15, 14 mm.; total length, 960 (incomplete), 1346, 1376 mm.; tail, 180 (incomplete), 380, 385 mm.

All three have four scales touching the first pair of chinshields which are slightly longer than second pair and separated by a few small scales; a single loreal, nearly twice as long as high; preoculars

separated from frontal; the seventh labial exceeds but little the size of the eighth (in one, smaller); the temporals are very irregular, but only a single anterior present, followed by two or three; the frontal is as long as, or only minutely less than, its distance to the tip of the snout; the parietals usually about one fifth longer than frontal; the eye equals its distance from nostril or is but slightly less; internasals are from two thirds to three fifths as long as the prefrontals.

The specimens agree in colors and markings. Above they are grayish-tan, save on the anterior part of body where the color is a strong lavender- or orchid-gray for a distance of six or eight inches behind head. There are faint suggestions of very narrow pinkish-white bars with some darker dots bordering them. The top of head is uniform dark amber; a cream spot present on the preocular; most of the upper labials are yellowish; a faint vertical light line crosses the seventh labial and extends above it; dorsal scales with fine black dots on apex, missing on some lateral scales, and absent on tail. Below yellow, the gray of sides encroaching on the ventrals; edges of ventrals on neck region, rosy, and on caudals a rosy or pinkish line, becoming lavender towards tip.

Natrix valida (Kennicott)

Regina valida Kennicott, Proc. Acad. Nat. Sci. Phila., 1860, p. 334. (Type description; type locality, Durango, Mexico.)

Tropidonotus validus Günther, Biologia Centrali-Americana, Reptilia and Batrachia, July 1894, p. 134. (Presidio and Mazatlán, etc.)

Four specimens were collected in the vicinity of Presidio, July 19 and 22. All were in the immediate vicinity of water.

The specimens Nos. 563, 564, 640, 641, present the following characters respectively: Sex, ♀, ♂, ♂, ♀; ventrals, 141, 143, 142, 146; subcaudals, 72, 76, 77, 73; supralabials, all 8-8; infralabials, all 10-10; preoculars, 1-1, 1-1, 1-1, 2-2; postoculars, 3-3, 3-3, 3-3, 2-2; temporals, 1+3+4, 1+2+4 : 1+3+4, 1+2+3 : 1+3 : 1+2+3; labials touch chinshields, all 5; loreal, 0-0, 1-1, 1-1, 1-1; anal, all, divided; scale formulae, 19-19-17-17, 20-19-17-17, 20-19-17-16, 19-19-17-17; (measurements in millimeters) head length, 35, 13.2, 24, 26; length to parietal, 25, 12, 18, 18; supraorbital width, 8, 5, 6, 8; length, 870, 308, 605, 635; tail, 207, 80, 155, 156; maxillary teeth number, of Nos. 563 and 640, 24-23, 24-24; mandibular teeth, 25, 25.

The three smaller specimens are uniform gray in color, and show two alternating rows of black spots on each side anteriorly. There

is a dim lateral line on second and third scale rows, below which the color is slightly darker; first six supralabials with black posterior edges.

Leptodeira maculata (Hallowell)

Leptodira personata Cope, Proc. Acad. Nat. Sci. Phila., 1868 (1869), p. 310. (Type description; type locality, "Mazatlán, Western Mexico"); Günther, Biologia Centrali-Americana, Reptiles, May, 1895, pp. 171, 172, pl. LIV, figs. A (adult, natural size) and B (young).

Two young specimens, No. 566 (ten miles south of Presidio, July 19) and No. 666 (one mile north of Presidio, July 23), were taken. Each was found hidden under a log in relatively dry situations. These present the following characters: Ventrals, 165, 167, subcaudals, 72, 68; supralabials, 8-8, 8-8; infralabials, 9-10, 10-10; preoculars, 1-1, 2-2 (the lower very small); temporals, 1+2+3, 1+1+2+3 (the anterior temporal segmented); anal, 2, 2; length, 280, 249 mm.; tail, 60, 54 mm.; spots on body, 24, 25; on tail, 12, 13; scale rows, 21-21-21-17; 21-23-23-17.

They agree in the following characters: Fourth and fifth suboculars enter the orbit; length of eye equal to its distance from center of nostril; loreal slightly longer than high; posterior chinshields about as long but somewhat more slender than anterior; five labials touch anterior chinshields; frontal with sides nearly parallel, in contact with the preocular (on one side in No. 666 it is minutely separated), equal to its distance to end of snout; scales with two apical pits.

In both specimens the blotches are somewhat diagonal across the back, and black in color. The dorsal ground color is faun. In No. 666 there is a foreshadowing of the darkening of the ground color, as occurs in the adult, by the appearance of black flecks low on the sides. The head is dark, and the parietals are partially outlined with yellowish-white, and somewhat lighter along the sutures of the other head scales; labials and ventral surface white. The nuchal collar is four or five scales wide, followed by the widest dorsal blotch covering nine to eleven scale rows medially.

The type has the preoculars, 2-1 (suggesting as do these specimens that these scales are variable), and the upper preocular is separated from the frontal.

Leptodeira punctata (Peters)

Crotaphopeltis punctatus Peters, Mon. Ber. Akad. Wiss. Berlin, 1866, p. 93. (Type description; type locality? South Africa.)

Leptodira pacifica Cope, Proc. Acad. Nat. Sci. Phila., 1868 (1869) p. 310. (Type description; type locality, Mazatlán; Bishoff, collector); Günther, Biologia Centrali-Americana, Reptilia and Batrachia, 1895, p. 169; Boulenger, Cat. Snakes Brit. Mus., III, 1896, p. 19 (Presidio, near Mazatlán).

Sibon pacificum Cope, Bull. U. S. Nat. Mus. No. 32, 1887, p. 67; Proc. U. S. Nat. Mus., XIV, 1892, p. 678.

Leptodira punctata Boulenger, The Zoöl., 1887, p. 178.

A single male specimen of this rare snake was captured late at night near a small railway bridge about a mile east of Mazatlán. The specimen was crawling along the bank of a small rivulet which held water from a rain of the previous night.

It presents the following characters: Portion of rostral visible above very narrow; frontal longer than its distance from the end of the snout, shorter than the parietals; nostril very large, pierced chiefly in the anterior part of the divided nasal; loreal small, as high as wide; two preoculars, the upper very high, the lower minute; two postoculars, both in contact with the single large anterior temporal; posterior temporals two; diameter of eye equal to its distance from the middle of the nostril. Upper labials 7-7, the sixth extremely large, the third and fourth entering the eye; anterior chinshields slightly wider but no longer than the posterior; latter scales separated from the first widened ventral by two pairs of small scales and two single enlarged scales; lower labials, 9-9, the first four touch the chinshields. Ventrals, 149; anal divided (preceded by a very small median scale); caudals, 70; terminal scale elongate, conical, with slight, lateral grooves. Length, 516 mm.; tail, 130 mm.; head width, 13 mm.; length to angle of jaw, 19 mm.

Color in life. Above slightly reddish-brown, with a series of black spots on either side of the median line extending to the tail; and on the side one or two indefinite rows of irregular black flecks tending to form angular reticulations. Head brown; four small dark spots on the parietals; a small median black spot borders the parietals and on either side of the nape are two large black spots narrowly separated by a yellowish area; labials very light tan; ventral surface cream.

Trimorphodon paucimaculatus sp. nov.

(Plate XLVI, fig. 1)

Holotype. E. H. T. No. 709, collected at Mazatlán, Sin., Mexico, July 24, 1934; E. H. Taylor, collector.

Diagnosis. A species related to *T. bi-scutatus* Duméril and Bibron, but not having the preoculars touching frontal, and with the dorsal spots greatly elongated and fewer in number. Frontal as long as parietal; prefrontals as wide as long. Ventrals, 253; anal divided; subcaudals, 76.

Description of the type. Part of rostral visible above equal to about one third its distance from the rostral; frontonasals a third wider than long; prefrontals very large, their greatest width about the same as their greatest length or slightly greater; frontal not

angular anteriorly, but with an acute angle posteriorly; length of frontal equal to that of the parietal, a little longer than its distance to the end of the snout; the width of the parietal about three fourths of its length. Nostril pierced in the nasal near the supranasal border, and a suture partially dividing the scale runs from nostril to the first labial; the scale is undivided above; three loreals, the anterior upper largest, higher than long, the posterior longer than high, the third loreal lies below and almost wholly posterior to the second loreal, and appears to be formed by a segmenting of the upper part of the third labial; three pre- and three postoculars, the upper preocular not especially large and well separated from the frontal; temporal formulae, 3+5+4+5, 3+4+5+4; upper labials, 9-9, the fourth and fifth entering orbit. The diameter of the eye equals the distance from posterior edge of the nasal; lower labials, 12-13, five touching the anterior chinshields; mental triangular; posterior chinshields less than half the anterior, and separated from the first ventral by five rows of scales; eight or nine scales between the first ventral and the last labial; ventrals angular, 253; anal divided; 76 subcaudals, the terminal scute with a dorsal, a ventral and two lateral grooves. Scale formula, 25-23-25-25-25-19-17 (last count made in front of anus). The teeth of this form seem fewer than those in typical *bi-scutatus* Duméril and Bibron. The number present is eight, the first two much enlarged, the first a little smaller than the second; the next five are subequal, rather widely spaced, but no teeth appear to be missing; and then after a space are two grooved teeth a little thicker but scarcely higher than the second tooth.

Color in life. A dim olive band, slightly black-edged, crosses snout slightly in advance of the eyes; followed by a lighter band that crosses head between, but curves back behind eyes to the angle of the jaw; this is followed by a broad, black-edged, arched, lavender-gray band nearly severed medially by a projection from the lighter arched mark following the preceding; behind this another wide arched band confluent with the first dorsal spot. General color light, grayish-lavender; on body, 20, on the tail 10 brownish-lavender, darker-edged, saddlelike spots, each with a lighter, dorsal, central portion and separated from the following spot by four or five scale rows, its length involving 11-12 transverse scale rows; a few small scattered spots along side of body; a few dark lavender flecks on the ventrals; body below dirty cream.

Measurements. Length, 880 mm.; tail, 142 mm.; head length to jaw angle, 25 mm.; width, 14 mm.

Remarks. This species is, as has been stated, related to *T. bi-scutatus.* The type locality for the latter is "Mexique," but the high ventral and subcaudal counts suggest a southern specimen. Boulenger (Cat. Snakes III, p. 54) lists a series of seven specimens from Mazatlán and Presidio (fifty miles south of Mazatlán?) which show a relatively uniform scale formula, 25 (24); ventral scales, 237-251 (average 247); subcaudals, 78 ♀ and 84-87 ♂, average for both sexes being 83.

Günther (Biol. Centrali-Amer., May, 1895, p. 174), writing of these and certain other specimens, states that they do not agree with the forms included in certain synopses presented by Cope. Neither Boulenger nor Günther comment on the markings or the relation of the upper preocular to the frontal. It seems likely that the *bi-scutatus* as used by Günther and Boulenger is a composite and it is quite probable that the lot mentioned above from Southern Sinaloa actually should be associated with this form.

Kinosternon hirtipes Wagler

Three specimens (Nos. 560, 689, 690), which I collected at Presidio, are in the hands of Dr. Norman Hartweg, who will include data on them in his study of the genus *Kinosternon.* I am indebted to him for this identification.

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PLATE XLIV

FIGURE

1. *Scaphiopus couchii* No. 2915 E. H. T. & H. M. S. Mazatlán, Sinaloa.
2. *Scaphiopus couchii* No. 2916 E. H. T. & H. M. S. Mazatlán, Sinaloa.
3. *Scaphiopus couchii* No. 2911 E. H. T. & H. M. S. Guaymas, Sonora.
4. *Scaphiopus couchii* No. 2912 E. H. T. & H. M. S. Guaymas, Sonora.

PLATE XLIV

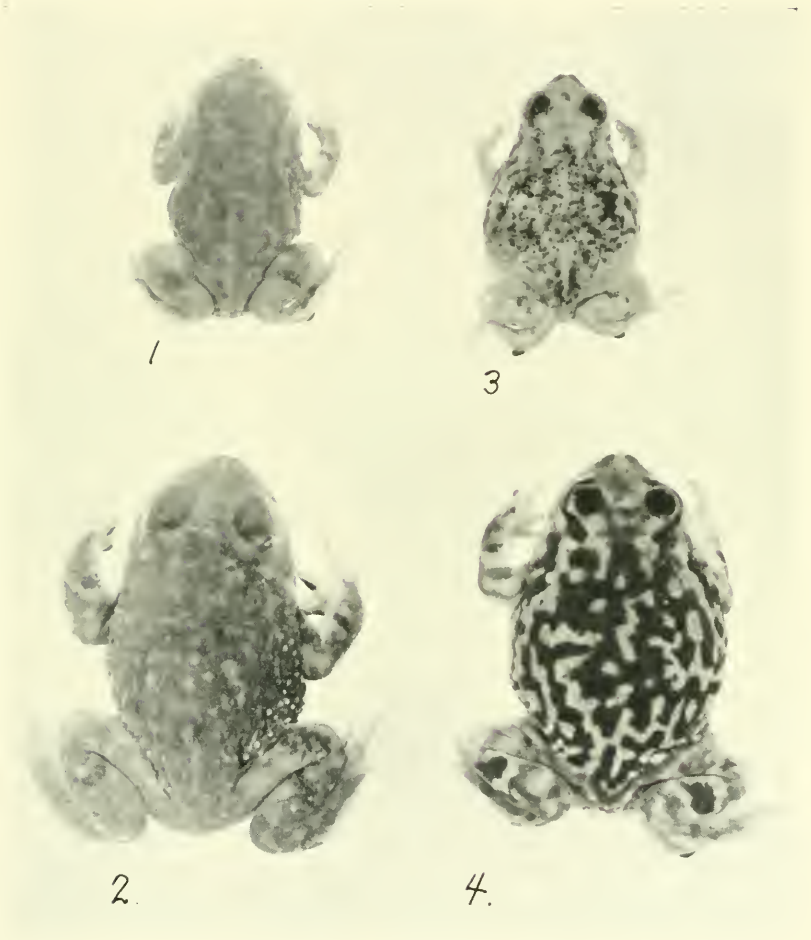

PLATE XLV

FIGURE

1. *Bufo kelloggi* No. 42 E. H. T. & H. M. S. young. Mazatlán, Sinaloa.
2. *Bufo kelloggi* No. 27 E. H. T. & H. M. S. ♂. Mazatlán, Sinaloa.
3. *Bufo kelloggi* No. 21 E. H. T. & H. M. S. Type. ♀. Mazatlán, Sinaloa.
4. *Bufo debilis* No. 11530 K. U. young. San Diego county, Texas.
5. *Bufo debilis* No. 21524 K. U. ♂. Benton, Atascosa county, Texas.
6. *Bufo debilis* No. 21526 K. U. ♀. Benton, Atascosa county, Texas.
7. *Bufo insidior* No. 64 E. H. T. & H. M. S. young. Two miles south Majoma, Zacatecas.
8. *Bufo insidior* No. 87 E. H. T. & H. M. S. ♂. Two miles south Majoma, Zacatecas.
9. *Bufo insidior* No. 123 E. H. T. & H. M. S. ♂. Fifteen miles south of Zacatecas, Zacatecas.

PLATE XLV

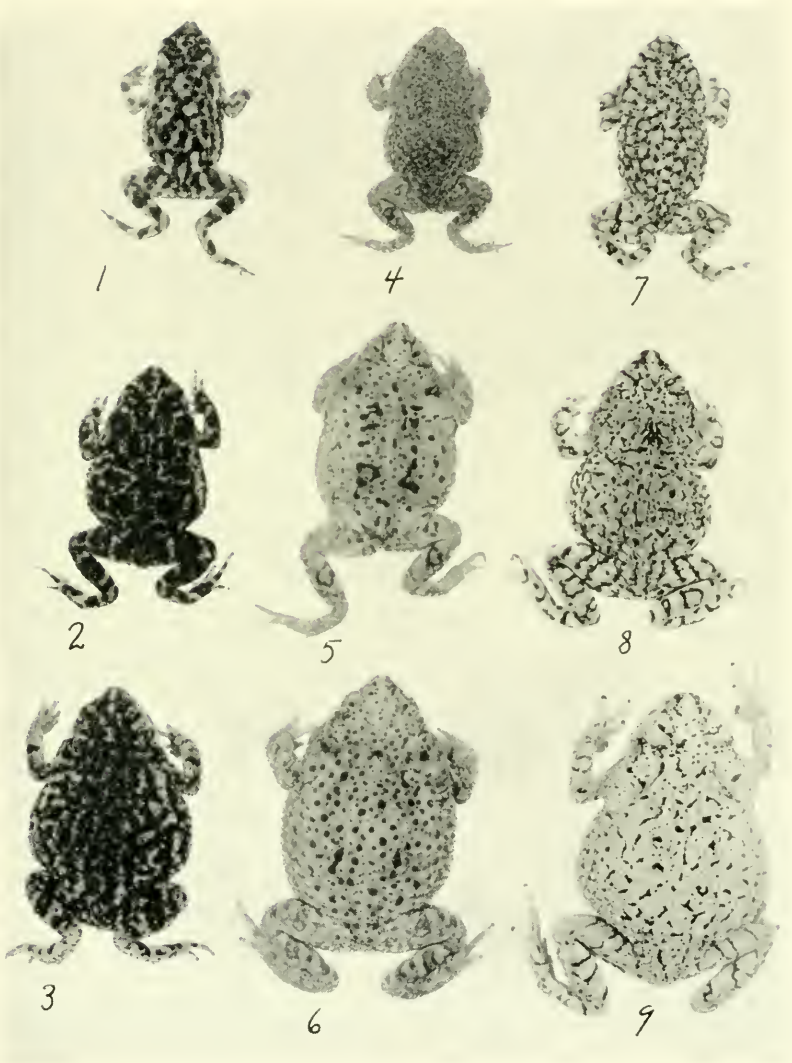

PLATE XLVI

FIGURE

1. *Trimorphodon paucimaculatus*, sp. nov. No. 709, E. H. T. Type. Head, enlarged. Actual size, length to angle of jaw, 25 mm., width, 14 mm. Mazatlán, Sinaloa.
2. *Coleonyx fasciatus* No. 556, E. H. T. Fifteen miles south of Presidio, Mazatlán, Sinaloa.

PLATE XLVI

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The Lizards of the Torquatus Group of the Genus *Sceloporus* Wiegmann, 1828*

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ABSTRACT: Complete synonymies, descriptions and a key are given for the recognized species and subspecies of the *torquatus* group, in which are included *serrifer, t. torquatus, t. melanogaster, bulleri, m. mucronatus, m. omiltemanus, cyanogenys, poinsettii, lineolateralis, j. jarrovii, j. minor, j. immucronatus, o. ornatus, o. caeruleus, d. dugesii* and *d. intermedius*. *S. ferrariperezi* Cope is synonymized with *S. t. torquatus* Wiegmann; *S. pleurolepis* Günther is synonymized with *S. d. dugesii* Bocourt. *S. guentheri* Stejneger is referred to the *spinosus* group. An analysis is presented of the phylogeny of the eleven proposed groups (*chrysostictus, scalaris, variabilis, utiformis, pyrocephalus, maculosus, microlepidotus, formosus, spinosus, undulatus* and *torquatus*) of the genus, and of the species and subspecies of the *torquatus* group. It is suggested that the genus *Uta* is derived from ancestral forms of *Sceloporus* whose most closely related living species are in the *variabilis* group.

INTRODUCTION

SCELOPORUS is one of the largest, most progressive and most recent of the new world lizard genera. Its extreme genetic activity has resulted in the appearance of numerous variations, many of which have not become fixed, partially because of an insufficiency of the time element, an inadequacy of their survival value, and unfavorable environmental conditions. A thorough re-

*After this manuscript was in press, Mr. Joseph R. Bailey kindly pointed out to me that, unfortunately, the name *Sceloporus torquatus* Wiegmann is not tenable. In 1820 Wied described *Stellio torquatus*, which was placed by Wied in his new genus *Tropidurus* described in 1824 (Abbild. Nat. Bras.). In 1828 Wiegmann described *Sceloporus torquatus*, which the same author designated as the genotype of *Sceloporus* in 1834. In 1830 Wagler placed *Sceloporus torquatus* (also *S. spinosus* and *gramnicus*) in the genus *Tropidurus*, together with *Tropidurus torquatus*. Thereby *Sceloporus torquatus* is suppressed as a homonym and cannot be resurrected.

The only names synonymous with *torquatus* are *melanogaster* Cope and *ferrariperezi* Cope, both described in 1885 in the same article. *S. melanogaster* is very definitely typical of the northern subspecies, while *ferrariperezi* is based upon intergrades between the northern and southern subspecies, definitely approaching the southern subspecies more closely than the northern. There seems to be no alternative for the selection of *ferrariperezi* as the name to replace *torquatus*. The specific and subspecific names of the races of the species previously known as *Sceloporus torquatus* Wiegmann should therefore be *Sceloporus ferrariperezi ferrariperezi* Cope and *Sceloporus ferrariperezi melanogaster* Cope.

As *Sceloporus poinsettii* Baird and Girard (1854) is the next oldest name in the group, I propose that the group previously known as the *torquatus* group be called the *poinsettii* group.

vision which describes and analyzes to a reasonable extent these extraordinarily numerous variations has long been one of the major desiderata in the study of American herpetology. Few American genera of lizards present to students of herpetology a greater array of taxonomic difficulties than this. The greatest difficulty encountered is the determination of the extent of fixation of the sundry variations; while a second difficulty is that of determining what degree of fixation is required that a variant population be given taxonomic recognition.

The several authors who have dealt with the genus have disagreed with each other in a surprising number of cases. They have expressed the result of their studies in one of two extremes—either the unwarranted recognition of individual or aberrant variations, or equally unwarranted synonymizing under one name of distinct species or subspecies which have in common certain obvious similarities but which also have dissimilar characters, overlooked or not well appreciated, which do define distinct and separate genetic entities.

This paper is presented as the first part of a proposed revision of the genus *Sceloporus*. It deals with one unit—the *torquatus* group. Of this group, about 1,300 specimens have been examined. Most of the Mexican material and many of the specimens from the United States are in the collections at the University of Kansas; and most of the specimens of this group in other museums of the United States have also been examined.

Studies of this nature must of a necessity be somewhat incomplete, because of the inadequacy of available material, the lack of more direct evidence of relationships, and the lack of absolute knowledge of the methods of speciation. Since such data are not available, in many cases the only recourse is to speculation, with a varying amount of probability of truth in each case. For these reasons many of the conclusions presented herewith must be considered tentative.

ACKNOWLEDGMENTS

It has been possible to complete the present work only through the invaluable courtesies of numerous individuals who have generously afforded aid. Among these I wish to express my indebtedness in particular to Dr. Edward H. Taylor, who has been of direct aid in many ways, and whose concepts of speciation and related phenomena have assisted in arriving at the conclusions here presented. I am indebted also to Dr. H. H. Lane, of the University of Kansas,

for much invaluable advice and assistance in other respects; to Mr. C. D. Bunker, curator of Dyche Museum of Birds and Mammals, for permission to study specimens under his care; to Dr. K. P. Schmidt, for permission to examine specimens in the Field Museum; to Mrs. Helen T. Gaige, for permission to examine specimens in the Museum of Zoölogy of the University of Michigan; to Dr. Howard K. Gloyd, of the same institution, for the opportunity of making field studies under his direction; to Dr. Thomas Barbour and Mr. Arthur Loveridge, for permission to examine specimens in the Museum of Comparative Zoölogy; to Mr. David H. Dunkle, of Harvard University; to Dr. G. K. Noble, for permission to study specimens in the American Museum of Natural History; to Mr. C. F. Kauffeld, of the same institution, for numerous courtesies; to Drs. Leonhard Stejneger and Doris Cochran, for permission to examine specimens in the United States National Museum; to Dr. H. W. Fowler, for permission to examine specimens in the Philadelphia Academy of Natural Sciences; to Mr. L. M. Klauber, for permission to examine specimens in his personal collection, and for various data; to Señores Dr. Isaac Ochoterena and Rafael Martín del Campo, of the Instituto de Biologia in Mexico City, for numerous courtesies; and to Dr R. H. Painter, of Kansas State College at Manhattan, for numerous courtesies.

The study has been aided financially by grants from the graduate research fund of the University of Kansas. The drawings have been made by Miss Myra Wildish, Mr. Russell Chezem, Mr. Carol Johnson and Mr. Maxim Eliashevich, all of the University of Kansas. The photographs are the work of Mr. Oren Bingham, also of the University of Kansas.

EXPLORATION

A difficulty frequently encountered by specialists in attempting to loosen taxonomic knots is that of securing an acquaintance with their subjects in their natural state. It has been my good fortune to observe in the field most of the species dealt with herein. My first opportunity was during the summer of 1930, collecting in Texas, New Mexico and Arizona with Mr. Howard K. Gloyd and his wife. In the summer of 1931 I collected in Texas and New Mexico with Dr. and Mrs. R. H. Painter, of Kansas State College at Manhattan. The introduction to Mexican Scelopori was made possible by Dr. Edward H. Taylor, whom I accompanied during the summer of 1932 on an expedition covering seventeen central and northern Mexican states. In the summer of 1934 Mr. David H. Dunkle, now at Har-

vard University, and myself, ventured again into northern Mexico. A third trip, which covered most of the other states of Mexico, was undertaken during the summer of 1935.

METHOD OF MEASUREMENT AND DESCRIPTION OF DIAGNOSTIC CHARACTERS

For each specimen studied in detail, forty-seven characters of proportion and scalation were recorded. Certain measurements included in the tables presented herewith may be explained. The distance from snout to occiput is measured from the posterior edge of the interparietal to the end of the snout, in a plane parallel with the edge of the mouth. The snout to ear measurement is taken from the posterior border of the ear, in a line parallel to the median vertical axis of the head. The hind leg is measured along its posterior border, from the insertion of the leg to the tip of the fourth toe, excluding the claw. The fourth toe is measured from the base of the fifth, and does not include the claw. The tibia is measured along its anterior border, flexing the tibia back against the femur, holding the metatarsus at right angles to the tibia, and measuring from the inner angle of the tibiometatarsal joint to the proximal end of the tibia.

The scales of importance in descriptions of species of the *torquatus* group are as follows:

Interparietal (occipital). A large scale in the middle at the posterior edge of the head, always single, with a spot marking the position of the parietal foramen. The scale is usually more or less square, and its relative size is of some importance. At birth of the animal the interparietal is quite large, and gradually decreases in relative size as the animal attains greater age. In species which attain greatest size, the interparietal is relatively the smallest.

Parietals. A single, usually more or less triangular parietal borders the interparietal on either side. I do not consider the smaller, smooth scales occasionally present behind this scale as parietals.

Frontoparietals. Normally a single pair of small, rectangular frontoparietals precede the parietals, separating the interparietal from the row of scales about the supraoculars. The frontoparietals may contact each other medially, or may be separated either by an azygous scale or by contact of the frontal with the interparietal. In some species the frontoparietals are usually divided into four scales.

Frontal. This is a large scale between the orbits, normally transversely divided into two sections, the anterior being somewhat larger than the posterior. In *ornatus* the tendency is to lose the posterior portion of the frontal, probably by fusion with adjacent scales. In

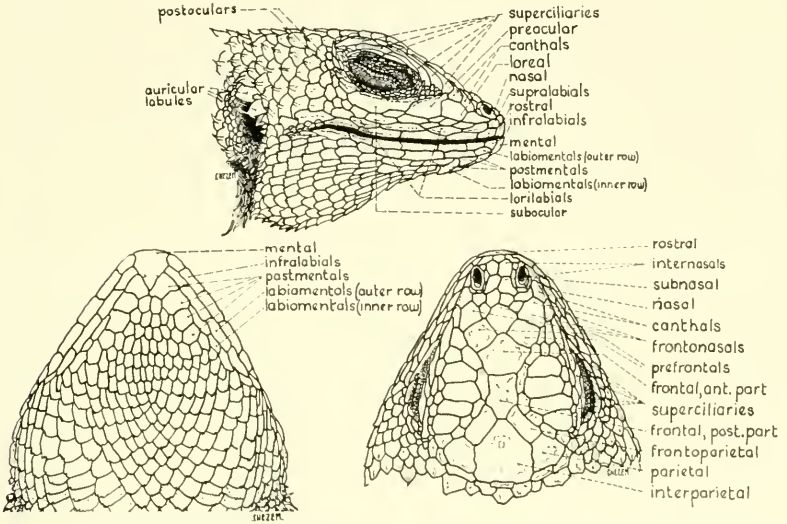

FIG. 1. Head scales of *Sceloporus torquatus melanogaster* (Cope), showing nomenclature adopted in this paper. DHD & HMS 453, near San Tiburcio, Zacatecas; actual head length, snout to occiput, 19 mm.

poinsettii the frontal is usually broken irregularly into several scales. It is significant that in species in which the supraoculars are in two rows, the frontal rarely or infrequently touches the interparietal. The reverse is the case in species having a single row of supraoculars.

Prefrontals. Two rather large scales preceding the frontal. They may be in contact medially, or separated either by the contact of the median frontonasal with the frontal or by an azygous scale.

Frontonasals. Three large scales preceding the prefrontals the median of which is usually slightly the largest and may be in contact with the frontal.

Internasals. Apparently two pairs of internasals is the ideal condition, but this condition is seldom realized. The scales are usually very irregularly divided.

Nasals. Small scales in which the nares are pierced. They are never divided, and are always separated from the rostral. An irregular series of small scales surrounds the nasals except below, where a subnasal is present.

Supraoculars. A series of large scales above the orbit, in some species divided irregularly, or, in others, into two regular rows. They are always separated from the median head scales by a single row of small scales varying in size and general shape according to species (except in *serrifer*, in which species the last supraocular may not be separated completely from the median head scales). One, two or three complete or incomplete rows of small scales separate the supraoculars from the superciliaries, more or less according to species or subspecies.

Superciliaries. Six superciliaries are always present, the first four imbricating posteriorly, the fifth completely hidden below the fourth, and the sixth overlapping the posterior part of the fourth.

Canthals. Typically two, the posterior of which does not extend far onto the superciliary region. The anterior canthal is, in some species, frequently forced above the canthal ridge by contact of the second (posterior) canthal with the subnasal.

Subnasal. A relatively large scale immediately below the nasal, in contact with the anterior canthal and loreal.

Loreal. A small scale below the canthals, in contact anteriorly with the subnasal and posteriorly with the preocular. It may rarely be divided into two or three scales. The first canthal occasionally separates the loreal from the subnasal and contacts the rows of scales above the supralabials.

Preocular. A small scale, with a heavy keel near its upper posterior edge, segmented from the anterior end of the subocular. The preocular is, in some species, divided longitudinally.

Subocular. A large, curved, elongate scale immediately below the eye, with a heavy keel near its upper edge.

Postoculars. Variable, usually two. They follow the subocular, curving posteriorly and upward at the edge of the orbit, and are distinguished from the temporal scales by being heavily keeled and usually somewhat larger.

Lorilabials. The small scales above the supralabials are so called. On the sides of the head they are usually in two rows, sometimes reduced to one row at some point below the subocular. One of these rows invariably continues about the snout, passing immediately above the rostral.

Supralabials. A series of scales around the upper labial border, excluding the scale at the tip of the snout. The scales of this series are smooth and nonimbricating, and do not vary sufficiently to be of assistance in distinguishing species and subspecies.

Infralabials. A series of scales around the lower labial border, excluding the scale at the mandibular symphysis. The scales of this series are similar in character to the supralabials.

Mental. A median anterior pentagonal or triangular scale bordering the lip.

Postmentals. A series of enlarged scales on each side posterior to the mental. The scales are paired; those of the anterior pair are always in contact medially, and those of the following pairs are separated from each other by a varying number of scales. The number of postmentals is irregular and of little taxonomic significance.

Labiomentals. Two series of scales on each side between the postmentals and infralabials. In some species the anterior scale of the outer row may usually contact the mental, and this condition is of some taxonomic significance. When the anterior scale of the outer row is separated from the mental, it is only by narrow contact of the first infralabial with the first postmental.

The inner row of labiomentals never extends as far forward as the outer row, and the position at which it terminates, in relation to the infralabials, is of considerable taxonomic significance.

Auricular lobules. These are the scales on the anterior border of the ear. Their number and relative size are of importance.

Lateral nuchal fold. A dermal pocket between the arm and the ear. The lining of this pocket is without scales or only with small, granular scales.

Postfemoral dermal pocket. A dermal pocket at the posterior margin of the insertion of the hind leg. The lining is without scales of any kind. It is not present in any species of the *torquatus* group.

Enlarged postanals. Two smooth, enlarged scales immediately posterior to the anus in males. They are normally present in all members of this group, but in *jarrovii* and its subspecies they are occasionally lacking or very poorly developed.

Femoral pores. A longitudinal series of pores along the posteroventral border of the thighs. The number of pores in each series is of much importance. They are always present in *Sceloporus,* and

in the *torquatus* group are never less than nine, and the series never approach each other closely on the median ventral line.

In a number of species of the *torquatus* group, the scales in the preanal region are modified in such a manner that they appear pore-like. They are not regularly so modified in any species of this group, and never occur in most species.

General character of scales. The dorsal scales of the body in species of the *torquatus* group are typically keeled, and with a terminal mucrone. In a number of species the median dorsal scales may lack terminal mucrones. The lateral scales are usually somewhat larger than the dorsal scales, and more strongly keeled and mucronate. Spines or denticulations, when present, are more numerous on the lateral scales than on the median dorsal scales. The dorsal caudal scales are usually somewhat larger than the median dorsal scales on the body. In *ornatus* the scales on the body have terminal pits.

The ventral scales are always smooth, and in most species are notched. The dorsal head scales are always pitted to some extent.

The dorsal scales of *dugesii* are remarkable in the fact that the terminal mucrone arises distinctly within the free margin of the scale. This is most evident on the lateral scales of the body, the dorsal scales of the thigh and the temporal scales. Related species show a tendency toward mucronation of this type. The extreme development is in *dugesii dugesii.*

The dorsal scale rows are usually parallel, occasionally convergent and rarely divergent. All three conditions may occur rarely in one species. No species has divergent scale rows except as an aberrant variation, while some species normally have convergent scale rows, with occasional variants possessing parallel scale rows.

Lamellar formulae. The number of lamellae under the free parts of the fingers and toes is of some importance in *Sceloporus.* The range of variation in the *torquatus* group is slight and of little significance. The lamellae are always tricarinate as in many other genera of Iguanidae.

Nuchal collar. The most important characteristic for definition of members of the *torquatus* group is the presence of a black, light-bordered collar about the neck, which may or may not be complete ventrally (only complete in males), according to species and age of the individual. The light borders may be incomplete (most incomplete in a certain phase of *jarrovii jarrovii*), but never absent. No species not belonging to the *torquatus* group has such a collar. How-

ever, certain species of related groups (*microlepidotus, formosus* and *spinosus*) may have black collars about the neck. These collars differ in lacking the light borders, and the species have other differential scale characters.

Ventral coloration. Females are light-colored below, and markings are confined, when present, to the gular region. Adult males always have some type of ventral coloration. Usually the gular area is bluish, as well as the sides of the abdomen. The blue areas on the sides of the abdomen may be black-bordered. In some species the entire ventral surface is blue.

Size. Maximum size is considered to be of as great importance as many of the scale characters. The range in maximum size, in the *torquatus* group, is from 75 mm. snout to vent (*ornatus caeruleus*) to 143 mm. (*cyanogenys*). *S. ornatus ornatus* and *S. dugesii intermedius* are approximately as small as *ornatus caeruleus,* while *torquatus melanogaster* approaches closely the size of *cyanogenys.*

In the tables of measurements and scale counts, when no museum is given for a certain specimen number, the Mexican collection at Kansas University is referred to.

HISTORICAL DISCUSSION

A number of revisions of *Sceloporus* have appeared since the description of the genus by Wiegmann in 1828. Six species were originally described in the genus—*torquatus, spinosus, grammicus, pleurostictus, aeneus,* and *scalaris,* of which *torquatus* is the generic type. In 1834 Wiegmann published his "Herpetologia Mexicana," in which he recognized nine species—*torquatus, formosus, spinosus, horridus, grammicus, microlepidotus, variabilis, aeneus* and *scalaris.* Duméril and Bibron, in 1837 (Erpétologie generale), recognized ten species, adding *undulatus* Latreille.

The next important work is that of Bocourt in the Mission Scientifique, in 1874. This author recognized twenty-two species. only two of which are of the *torquatus* group (*torquatus* and *dugesii.*). He also recognized *poinsettii* as a variety of *torquatus. S. ornatus,* described in 1859 by Baird, and *serrifer,* described by Cope in 1866, are mentioned without description.

In 1885 Cope published a synopsis of *Sceloporus,* in which he recognized thirty-six species and subspecies, eleven of which belong to the *torquatus* group. At that time only one other species of the group had been described which Cope did not recognize—*intermedius* Dugès (1877).

In the same year, the catalogue of the lizards in the British Museum, by Boulenger, appeared, and in this thirty-three species and subspecies were recognized, nine of which are of the *torquatus* group.

In 1890 Günther published a synopsis of *Sceloporus* in Biologia Centrali-Americana, recognizing thirty species. Seven other described forms are listed without comment as to validity.

In 1897 Boulenger presented his conclusions with regard to the species of *Sceloporus* in his revision of the genus. He recognized thirty-six species and subspecies, seven of which belong to the *torquatus* group.

The last monograph of the genus is that of Cope, published in 1900, in "The Crocodilians, Lizards and Snakes of North America." In this are recognized forty species and subspecies, eleven of which belong to the *torquatus* group.

In this work, which deals with the *torquatus* group, I recognize as valid sixteen species and subspecies. These include only ten of the twelve recognized by Cope (1900), together with two previously described.*

GROUPS IN THE GENUS

It appears that the genus is divisible into eleven fairly definite groups, which I name as follows: *torquatus, formosus, microlepidotus, variabilis, scalaris, siniferus, spinosus, utiformis, undulatus, pyrocephalus* and *maculosus*. Of these eleven groups, the *torquatus, spinosus* and *undulatus* groups are the largest. The species of the *spinosus* group are well differentiated and bespeak an age greater than that of the *undulatus* and *torquatus* groups. In these two groups subspecies are numerous and their separation is comparatively difficult.

PHYLOGENY OF THE GENUS *SCELOPORUS*

Sceloporus is one of the most nearly ideal of living genera of reptiles for the study of speciation and related phenomena. The characteristics which it possesses and which are essential to an ideal genus for such studies are:

1. *A large number of living forms.* One hundred and seven species and subspecies have been described. Approximately eighty-two of these are valid.

2. *Prolificity.* Where *Sceloporus* occurs, usually it is the most common of all reptiles, or for that matter, of all vertebrates.

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* It appears that *Sceloporus guentheri* Stejneger (1918) does not belong to the *torquatus* group, but probably to the *spinosus* group.

3. *A large range, entirely contiguous.* The genus occupies practically all of the United States, and occurs as far south as Panamá.

4. *Great adaptability.* Species in this genus have adapted themselves to a considerable range of elevation—from below sea level (Death Valley) to about 13,500 feet above sea level. They occur in almost every conceivable terrestrial habitat—deserts, sand dunes, forests, on rocks, trees, or ground, in grassy plains or heavy brush, and even on houses, fences and other man-made structures.

5. *Lack of obvious distinctive specific characters.* Subspecies are numerous and species not so well defined as in many other genera of animals, and for this reason relationships may more definitely be postulated.

These characters are indicative of a group of relatively recent development.

It seems likely that *Uta* has been derived from *Sceloporus*. *Uta* is undoubtedly more closely related to *Sceloporus* than any other living genus. I assume this to be true because of the remarkably close agreement of certain members of the *variabilis* group of *Sceloporus* with certain members of the *ornata* group of *Uta*. I present the following data in support of this view.

A postfemoral dermal pocket is known to be regularly present in *Uta ornata* and its subspecies, *U. caerulea, U. levis, U. stansburiana hesperis,* and *U. taylori,* and is variable in certain other species and subspecies.

In certain species of *Sceloporus* of the *variabilis* group, a vestigial gular fold is present immediately in front of the arm which is homologous with the gular fold present in *Uta*. In *Sceloporus* it is most distinct in *S. couchii* and *S. merriami*. In the former species, there is present also a postfemoral dermal pocket immediately behind the insertion of the hind leg. The dorsal scales are extremely small for the genus, the laterals are minute and the size of the species itself is small.

In *Uta levis* (as well as in the related *U. ornata*), the gular fold is remarkably poorly developed. It is frequently interrupted medially, the scales of the gular region passing directly into the ventrals; in many cases in which the fold is not thus completely interrupted, small scales replace medially the tiny lateral granules. In *U. levis* the lateral scales are uniform in size and very minute—practically granular—but visibly imbricated. The enlarged dorsals are in some specimens in several rows, gradually decreasing in size laterally and

grading into the lateral scales. Also, the dermal pocket is present behind the insertion of the hind leg, as in *S. couchii.* Its size is comparable with that of the latter.

It is not a far cry from the smaller, almost granular lateral scales of *Uta levis* to the larger, but yet minute, laterals of *S. couchii;* nor is it impossible to conceive of an increase in size of the lateral dorsals from a few rows of enlarged scales to several or many. The vestigial gular fold of *S. couchii* is comparable with the partially developed fold of *Uta levis.* A postfemoral dermal pocket is present in each, and the sizes of the species are comparable.

It may be stated that the nearest point of contact between the two genera, so far as it may be traced in living forms, is between the species *levis* of *Uta* and *couchii* of *Sceloporus.* It cannot be said that either gave rise to the other; it is more likely that the two diverged from an ancestral type not greatly different from the above two species. By this view the *variabilis* group (to which *couchii* belongs) is the most primitive of the genus, while the *torquatus* group is probably the most highly specialized.

It appears that the *Sceloporus* stock, early in its evolution, separated into two divisions; from one came the large-scaled forms, mostly of large size, and from the other came the small-scaled forms, all of small size. From the latter division developed, among others, the *variabilis* group.

The extensive range of *Uta,* although smaller than that of *Sceloporus,* and the relatively considerable amount of speciation, would indicate that *Uta* is of considerable age. It would follow that the *variabilis* group of *Sceloporus* and the *ornata* group of *Uta* are relatively ancient, yet of much more recent development than the ancestral stock which gave rise to the other groups of *Sceloporus.* I assume that the *ornata* group is primitive to other groups of *Uta;* but it appears that the *variabilis* group is a specialized, divergent group which has given rise, not to other species and groups of *Sceloporus,* but to the quite distinctive genus *Uta.*

The groups of the small-scaled division of *Sceloporus* are, for the most part, difficult to allocate in a phylogenetic scheme, due to their rather vague relationships. The following discussion may support the tentative arrangement as here adopted.

Of the small-scaled forms, the *chrysostictus* group first became stabilized. The *variabilis* group is undoubtedly closely related to the *chrysostictus* group. *S. cochranae* (of the *chrysostictus* group) very closely resembles *variabilis variabilis,* differing most markedly in the

absence of a postfemoral dermal pocket. The *pyrocephalus* group possesses a species (*gadoviae*) which shows relationship with *variabilis* by the possession of a postfemoral dermal pocket, and is associated with the *variabilis* stem. The *utiformis* group also shows direct relationship with the *variabilis* stem through *S. merriami*, which possesses a prominent vestigial gular fold. Both members of the *utiformis* group (*utiformis* and *merriami*) possess granular lateral scales.

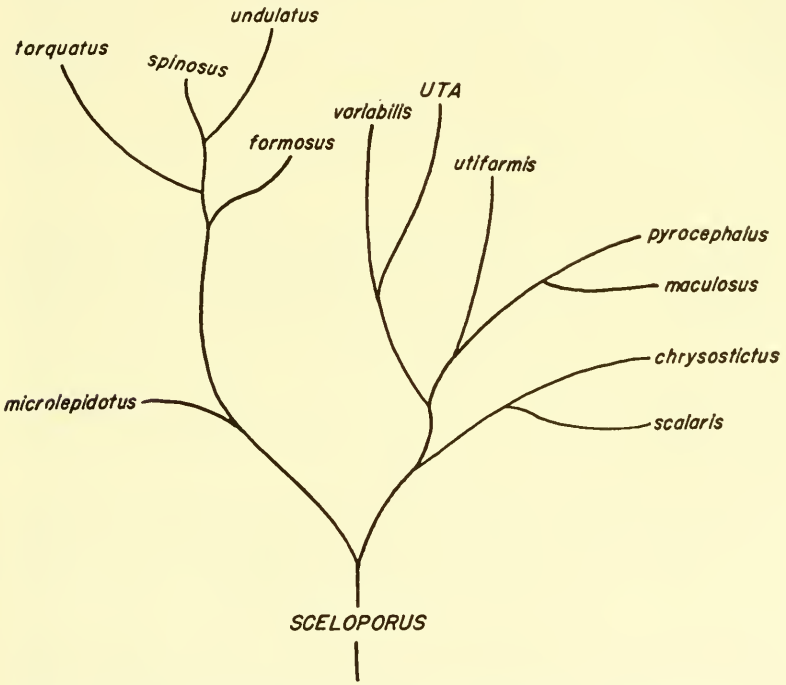

FIG. 2. Diagram illustrating the proposed phylogeny of the groups of *Sceloporus*. Generic names are in caps, group names in lower case.

The *scalaris* group has its closest relatives in the *chrysostictus* group, through *jalapae* of the former group and *ochoterenae* of the latter group.

The *maculosus* group, containing the single species *maculosus*, has no very close relatives, and is difficult to place in a phylogenetic tree. I assume, however, that its closest relationship is with the *pyrocephalus* group, through *S. nelsoni* of the latter group. *S. maculosus* certainly has no close relationship to the *variabilis* group, lacking all specialized characters of the latter group; from the *sca-*

laris group it differs widely in possessing oblique rows of lateral scales and smooth head scales; from the *chrysostictus* group it differs in lacking keeled preanal scales in females, and rugose head scales. The *utiformis* group is widely different from *maculosus* in the character of the lateral scales and the presence of a vestigial gular fold.

The remaining five groups (*microlepidotus, formosus, spinosus, undulatus* and *torquatus*) apparently have no close relationship with the other groups, and apparently diverged from a common stock which early separated from the other. The *microlepidotus* group is assumed to be the most primitive of these, largely because of its very small scales. The habitus of the species of this group and the fact that the species are ovoviviparous associate them definitely with the *torquatus* and *formosus* groups. Certain species of the *microlepidotus* group have large scales and closely resemble forms of the *formosus* group.

The *formosus* group appears to be near the common ancestral stock of both the *spinosus* and *torquatus* groups, through *acanthinus* of the former group and *serrifer* of the latter group. It may be added that these two species are also the most closely related of the *spinosus* and *torquatus* groups, respectively.

The *undulatus* group undoubtedly is most closely related to the *spinosus* group, through *undulatus* of the former group and *floridanus* of the latter.

Two apparent discrepancies appear in the arrangement of the last five groups discussed. First, all are of relatively large size except the *undulatus* group; and second, three groups are ovoviviparous (*microlepidotus, torquatus* and *formosus*) and the other two are oviparous.

The relatively small size of the species of the *undulatus* group must be assumed as a parallel development rather than a direct inheritance of the small size of the ancestor in the *varibilis* group, for the close relationship of the *spinosus* and *undulatus* groups cannot logically be disputed, nor is the close relationship of the *spinosus, torquatus* and *formosus* groups doubtful. It is possible, or even likely, that certain primitive species of the *spinosus* group, such as *acanthinus,* may be ovoviviparous, and that this character has been dropped in the further evolution of the group. It is well known that both ovoviviparity and oviparity occur in closely related species of *Phrynosoma.*

DISCUSSION OF THE TORQUATUS GROUP

Habits and habitat. As a rule, species of this group are confined to rocky habitats. So far as I am aware, only *cyanogenys* tends to live on or near the ground. *S. jarrovii* occasionally, and *serrifer* perhaps usually, are found on trees. Individuals of most species are extremely wary and difficult of acquisition. In central Mexico a number of species are found on rock fences in great abundance.

Mating probably takes place in early spring, inasmuch as the young are born in May or early June. Several species of this group are known to be ovoviviparous, and the remainder are presumed to be so.

Species included. The following species have been described:

S. bulleri Boulenger (1894, pp. 729-730, pl. 48, fig. 3).
S. ornatus caeruleus Smith.
S. torquatus cyanogenys Cope (1885, p. 402).
S. dugesii Bocourt (1874, pp. 188-190, pl. 18, figs. 7, 7a, 7b).
S. ferrariperezi Cope (1885, p. 400).
S. jarrovii immucronatus Smith.
S. intermedius Dugès (1877, pp. 29-34, pl. 1, figs. 21-32).
S. jarrovii Cope (1875, pp. 569-571, pl. 23, figs. 2-2d).
S. lineolateralis Smith.
S. melanogaster Cope (1885, pp. 400-401).
S. torquatus minor Cope (1885, p. 402).
S. torquatus mucronatus Cope (1885, p. 402).
S. omiltemanus Günther (1890, p. 66, pl. 32, fig. A).
S. ornatus Baird (1859, p. 254).
S. poinsettii Baird and Girard (1854, pp. 126-127).
S. torquatus Wiegmann (1828, p. 369).
S. pleurolepis Günther (1890, pp. 74-75, pl. 32, fig. B).
S. serrifer Cope (1866, pp. 124-125).

It is proposed herein that the following names should be recognized:

S. bulleri Boulenger.
S. cyanogenys (Cope).
S. dugesii dugesii Bocourt.
S. dugesii intermedius (Dugès).
S. jarrovii jarrovii Cope.
S. jarrovii minor (Cope).
S. jarrovii immucronatus Smith.
S. lineolateralis Smith.
S. mucronatus mucronatus (Cope).
S. mucronatus omiltemanus (Günther).
S. ornatus ornatus Baird.
S. ornatus caeruleus Smith.
S. poinsettii Baird and Girard.
S. serrifer Cope.
S. torquatus torquatus Wiegmann.
S. torquatus melanogaster (Cope).

I regard it necessary to synonymize Cope's *ferrariperezi* with *t. torquatus* Wiegmann, and Günther's *pleurolepis* with *d. dugesii* Bocourt.

It appears that soon after the separation of the *torquatus* stock from the other groups of *Sceloporus,* there was a separation into two divisions, one of which exhibited a tendency to develop small scales,

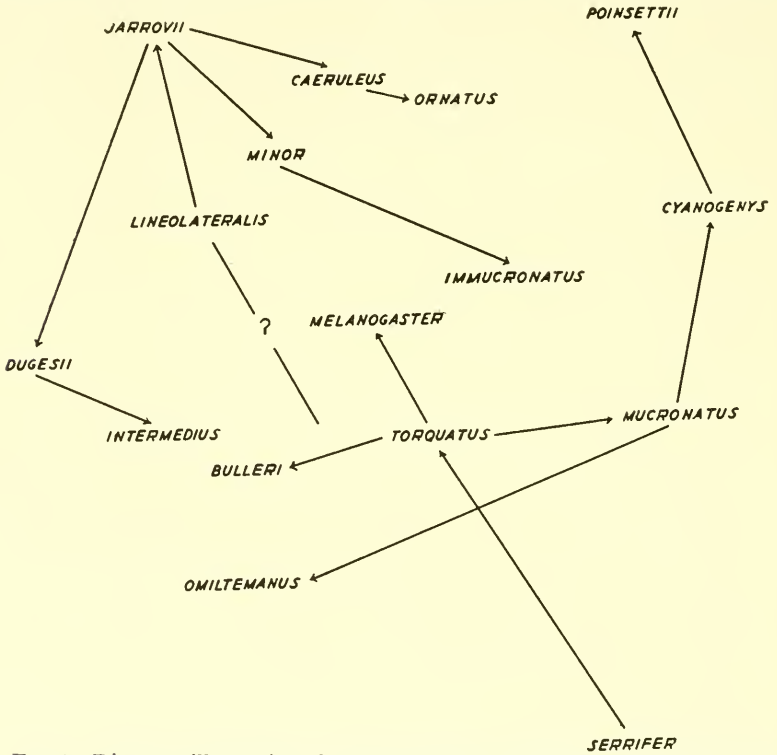

FIG. 3. Diagram illustrating the geographical relationships and derivations of species and subspecies of the *torquatus* group. Overlapping of ranges is not indicated.

the other large scales. This small-scaled division is now composed of species of smaller size, while the large-scaled division is composed of species of larger size. In the latter, the maximum size of its smallest species is greater than the maximum size of the largest species of the small-scaled division. Each division contains certain species having one row of supraoculars and others having two rows. This character of the supraoculars I would consider to be of less importance in distinguishing major divisions than maximum size of species or size of scales on the body, because of the greater variability and more erratic appearance of this character in species not closely related.

S. serrifer appears to be the oldest of the large-scaled species. The postulation that this species, which is one of the larger ones of the genus, and one having large scales, is nearest to the ancestral type of the large-scaled division of the *torquatus* group may appear to be contradictory to the postulation that *Sceloporus* is derived from

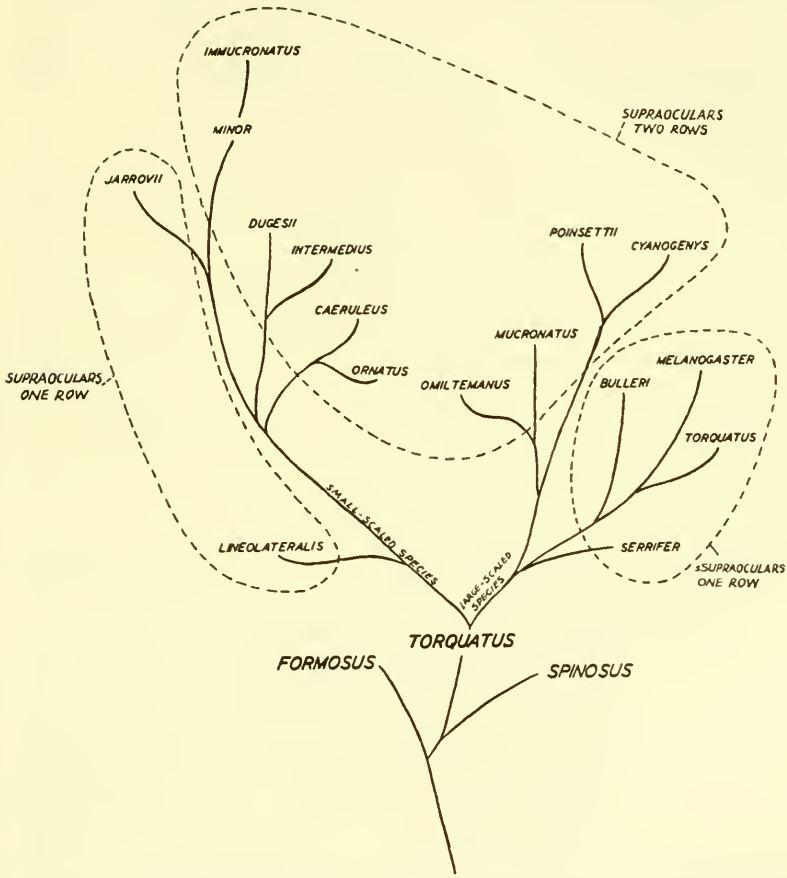

FIG. 4. Diagram illustrating the proposed phylogeny of species and subspecies of the *torquatus* group. Group names are given in larger letters.

small species with small scales. However, my assumption seems to be justified by the fact that *serrifer* occupies a southern position on the periphery of the geographical area now occupied by the *torquatus* group; and by the fact that it shows its closest relationship with the more primitive forms in the same area of the *spinosus* and *formosus* groups, which are obviously older, as indicated by the clearer definition of the species associated with them, and the fact that their present geographical distribution is peripheral to the gen-

eral area now occupied by the genus. The *formosus* group has, moreover, a discontinuous distribution also indicative of greater age.

Of the other species of the large-scaled division of the *torquatus* group, *cyanogenys, poinsettii* and *omiltemanus* have scales smaller than the remainder, and are for this reason considered to have diverged early from the restricted *torquatus* stem. *S. mucronatus* appears to be the nearest to the ancestral type of these three species, despite the fact that it has larger scales than they. I so conclude because of its centralized geographical position with relation to the area occupied by the other three forms.

Of the small scaled species, it appears that *lineolateralis* is the oldest living species. I am led to this belief because of the fact that this species occupies a relatively isolated area between the area occupied by most members of the small-scaled division and that occupied by most members of the large-scaled division. Further, it combines certain features of scalation more characteristic of species in the large-scaled division with other features more characteristic of species in the small-scaled division. *S. jarrovii* appears to be most closely related to *lineolateralis*. From this species, or its ancestors, the remaining species of the small-scaled division have obviously been derived.

KEY TO SPECIES

A. Supraoculars in a single series, with no scale divided.
  B. Femoral pores, 8 to 14; dorsal scales, 28 to 35.....*S. serrifer* Cope, page 558
  BB. Femoral pores, more than 14; or, dorsal scales, more than 35.
    C. Dorsal scales, 31 or less.
      D. Nuchal collar divided on each side of neck, the area between lighter in color; dorsal color light, with dark and light spots irregularly placed; size large (maximum snout to vent measurement, 129 mm.); dorsal scales more strongly keeled and mucronate.
S. torquatus melanogaster (Cope), page 571
      DD. Nuchal collar broad, complete; dorsal color dark, without light spots; maximum snout-vent measurement, 98 mm.; dorsal scales more weakly keeled and mucronate.
S. torquatus torquatus Wiegmann, page 564
    CC. Dorsal scales, more than 31.
      D. Lateral scales about half as large as median dorsals.
S. lineolateralis Smith, page 617
      DD. Lateral scales as large as or larger than dorsals.
        E. Dorsal scales, 40 or more; nuchal collar narrow, with light borders broken; a light line on side of head and another on side of neck; each dorsal scale usually with a light medial spot.....*S. jarrovii jarrovii* Cope, page 624
        EE. Dorsal scales usually less than 40; nuchal collar broad, with unbroken light borders; no light lines on sides of head and neck; no spots on dorsal scales....*S. bulleri* Boulenger, page 579
AA. Supraoculars in two series; or, if in one series, with one or more scales divided.
  B. Lateral scales with the terminal mucrone arising well within the free posterior margin; dorsal scales 41 or more.
    C. Dorsal scales, 47 to 54; throat with very distinct, oblique, dark-blue lines; head scales not rugose (microscopically); oblique dark bands on sides of body distinct; maximum snout-vent measurement, 79 mm.
S. dugesii intermedius (Dugès), page 663

CC. Dorsal scales, 41 to 50; throat without or with very dim oblique lines; head scales rugose (microscopically); oblique dark bands on sides of body indistinct or absent; maximum snout-vent measurement, 87.5 mm.; femoral pores, not over 13.....*S. dugesii dugesii* Bocourt, page 657

BB. Lateral scales with the terminal mucrone arising at or very near the free posterior margin; head scales not rugose (microscopically); no oblique, dark-blue lines on throat.

C. Dorsal scales, 55 or more.....*S. ornatus ornatus* Baird, page 647

CC. Dorsal scales, less than 55.

D. Dorsal scales, 47 to 53.....*S. ornatus caeruleus* Smith, page 652

DD. Dorsal scales, less than 47.

E. Black nuchal collar six to eight scales broad; supraoculars usually in two complete rows; irregular dark markings frequently present on throat; dorsals, 34 to 46; series of dorsal scales never with longitudinal light and dark lines; maximum snout-vent measurement, 101 mm.

S. jarrovii minor (Cope), page 631

EE. Black nuchal collar less than six scales broad.

F. Nuchal collar two or three scales broad; general ground color blue, at least in males; males with the entire belly black and blue; dorsal scales, 37 to 46; maximum snout-vent measurement, 87 mm.

S. jarrovii immucronatus Smith, page 640

FF. Nuchal collar more than two or three scales broad; maximum snout-vent measurement no less than 100 mm.

G. Tail with very distinct, broad, alternating dark and light bands, most distinct toward tip of tail, where they are complete; supraoculars in two complete rows; head scales very irregular; light borders of nuchal collar broad; a broad light band across neck behind occiput; preocular usually entire; inner row of labiomental scales usually terminating at a point posterior to suture between second and third infralabials.

S. poinsettii Baird and Girard, page 606

GG. Tail without distinct alternating dark and light bands of nearly equal width; bands about tail not complete toward tip; dorsal scales, 40 or less.

H. Dorsal scales, 31 or less; two parallel dark lines down middle of throat (except in adult males); a broad median dark band usually visible, composed of about five large dim blotches.

S. mucronatus mucronatus (Cope), page 583

HH. Dorsal scales, more than 31; or, if less, without parallel lines down middle of throat; without a median dark band.

I. Light borders of nuchal collar usually unbroken medially; upper auricular lobule much enlarged; each dorsal scale row usually with a longitudinal light line; general dorsal coloration dark; maximum snout-vent measurement, 114 mm.....*S. mucronatus omiltemanus* (Günther), page 591

II. Light borders of nuchal collar usually broken medially; auricular lobules not well differentiated; no lines on dorsal scale rows; general dorsal coloration very light, usually of a shade of blue; maximum snout-vent measurement, 143 mm.....*S. cyanogenys* (Cope), page 599

Sceloporus serrifer Cope

(Text figs. 5 and 6; plate XLVII, fig. 2)

Sceloporus serrifer Cope, 1866, pp. 124-125; *idem*, 1885, p. 401; Boulenger, 1885, p. 221; Cope, 1887, p. 37; Günther, 1890, pp. XIII, 77; Boulenger, 1897, p. 488; Cope, 1900, p. 336; Barbour and Cole, 1906, p. 150; Stejneger, 1918, pp. 91-92.

Sceleporus serrifer Werner, 1896, pp. 346, 352; *idem*, 1903, p. 344.

Sceloporus torquatus serrifer Stuart, 1934, p. 11; *idem*, 1935, p. 45.

Type locality. Yucatán. Type USNM 24868; apparently seven paratypes, USNM 10298, 24869-74; all collected by Arthur Schott.

Diagnosis. A member of the *torquatus* group; dorsal scales, 28 to 35 from occiput to base of tail; femoral pores, eight to fourteen; supraoculars in a single row, entire, the last occasionally in partial contact with median head scales; tibia about equal to length of shielded part of head; length of fourth toe usually greater than snout-ear measurement; general dorsal coloration light; nuchal collar complete, light bordered; parietals, interparietal and posterior part of frontal each with a conspicuous light spot; several light spots or bands on neek; each dorsal scale with a black median streak along the keel in females; throat bluish, reticulated or spotted with white or cream; middle of belly and usually the chest cream or white in males.

Description (from E.H.T & H.M.S. 2212, male). Head and body not flattened; head scales pitted (especially in prefrontal and internasal regions), not keeled, slightly convex; parietals single on each side, subtriangular, about one fourth size of interparietal; latter hexagonal; frontoparietal single on each side, subrectangular, two thirds the size of either parietal, separated medially by a small azygous scale; posterior section of frontal about one fourth size of anterior section; prefrontals in contact medially, their eommon suture about one fourth their maximum length; prefrontals narrowly separated from second eanthals, slightly less than one half size of anterior section of frontal; median frontonasal shield-shaped, slightly larger than either lateral frontonasal; two small, broad, short scales in front of median frontonasal; these preceded by a median pair of rather large, long internasals, separated from rostral by a row of small scales; nasal small, the naris piereed nearly in the middle, leaving a narrow border, somewhat wider and tapering anteriorly; subnasal small; first canthal larger than second, not forced above canthal ridge, not in contact with lorilabials, somewhat U-shaped (probably fused with loreal); supraoculars 4-4, separated from median head scales by a single row of small scales, from superciliaries by a single row of very small scales; preocular divided; sub-

ocular followed posteriorly by two short, strongly keeled, well-differentiated postoculars; two rows of labiomentals, not reduced below subocular; three and one half or four and one half supralabials and five infralabials to a point below middle of eye.

Mental pentagonal, its labial border slightly more than half that of rostral; mental followed by three or four pairs of postmentals, the scales of the anterior pair in contact with each other; outer row of labiomentals separated from mental by a narrow contact of first postmental and first infralabial; inner row of labiomentals terminating anteriorly even with the anterior part of third infra-

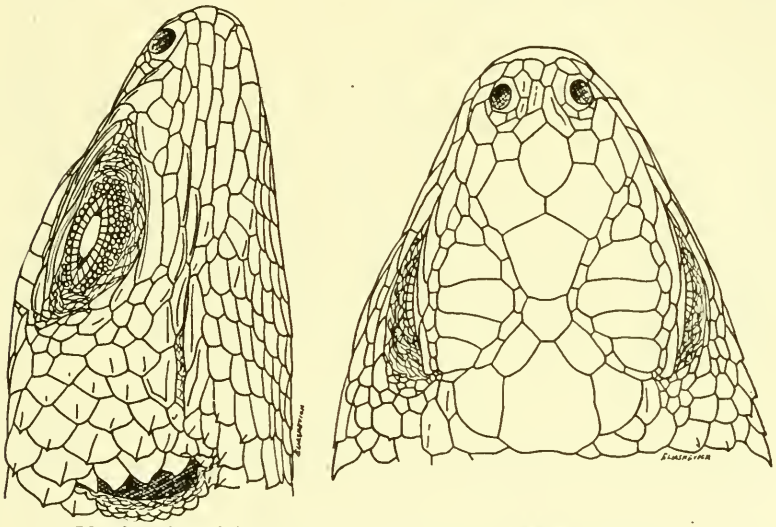

FIG. 5. Head scales of *Sceloporus serrifer* Cope. UMMZ 71771, near Mérida, Yucatán; actual head length, snout to occiput, 15.7 mm.

labial; gular scales smooth, smallest anteriorly, largest laterally near angle of jaws, with as many as three apical notches; notches more numerous on posterior gular scales, absent on anterior gular scales.

Ear with four auricular lobules, smooth, rounded or pointed, not well differentiated, smaller than preceding scales; scales between ear and lateral nuchal fold subequal in size to those in temporal region, but more strongly keeled and mucronate; a fold of skin between nuchal pocket and a point below lower edge of ear, surmounted by very strongly mucronate scales; dorsal scales weakly keeled, strongly mucronate, with numerous lateral denticulations; lateral scales equal to or somewhat smaller than dorsal scales, more strongly keeled, mucronate and denticulate; ventral abdominal scales smooth, slightly more than one half the size of median dorsals, each with a single apical notch; median gular scales about two thirds size of

median abdominals, subequal in size to preanals; subcaudals smooth except toward tip of tail; postanals enlarged, separated by two small scales; dorsal caudals toward base of tail somewhat larger than median dorsals on body.

Dorsal scales of foreleg keeled, mucronate, denticulate, those on upper foreleg about two thirds size of median dorsals on body and about one third larger than dorsal scales on lower foreleg; ventral scales of foreleg smooth, slightly mucronate, those on lower foreleg somewhat smaller than dorsal scales of same member, much larger than ventral scales of upper foreleg; lamellar formula for fingers, 10-15-18-19-15 (10-15-20-20-15).

Dorsal scales of hind leg keeled, strongly mucronate, very weakly denticulate, those on thigh two thirds the size of median dorsals on back, those on shank slightly smaller than dorsals on body; ventral scales on shank smooth, rounded, slightly smaller than dorsals of same member; ventral scales of thigh smooth, notched, those immediately preceding femoral pores subequal in size to preanal scales; scales on posterior surface of thigh strongly keeled, strongly mucronate, denticulate, nearly twice as large as preanal scales, abruptly decreasing in size near femoral pores; no postfemoral dermal pocket; lamellar formula for toes, 9-15-19-24-17 (9-15-19-23-17).

Color. Black nuchal collar broad, about four scales wide in median dorsal line, continued across throat in males; collar bordered on either side by a light band about one scale wide, the posterior of which is complete and passes onto the foreleg near its insertion; the anterior light border broken medially, terminating laterally at the upper edge of the lateral nuchal fold; keels on dorsal scales black, producing the effect of a narrow dark line down the middle of each scale row; a transverse series of light spots across neck between ears; a light spot in the center of the interparietal and each parietal; a narrow light band across the middle of the orbits (may be represented by only a light spot on the posterior section of the frontal); a light band across the prefrontals (very dimly visible in males); tail dimly banded with light brown and olive.

Males uniform olive or brownish olive on back and limbs; throat stippled heavily with blue and black, increasing in intensity toward gular fold region, which is black; ventral surfaces of limbs, chest and a narrow median abdominal band white; sides of belly caerulean blue, tinged with purple; a rather broad black band (about three scales wide) bordering lateral blue areas, involving groin, rarely reaching to black of gular region.

Females brownish olive on back and limbs, with scattered irregular dark-brown spots; ventral surfaces uniform whitish.

Variation. The variation in head scales of fifty-three specimens is as follows: Parietal one third to one fifth size of interparietal; frontoparietals divided on one side in one; frontal touches interparietal in twenty-three; frontoparietals contact medially in twenty-one; an azygous scale separates frontoparietals medially in nine; entire frontal longitudinally divided in three specimens; anterior section of frontal divided longitudinally in two specimens; frontal divided transversely in two places in one specimen; frontal entire in six specimens; prefrontals contact medially in forty-two; median frontonasal contacts frontal in six; an azygous scale separates them in five; the supraoculars are entire in all, usually four on each side, sometimes five; usually but a single row of scales separates the supraoculars from the superciliaries; in a few specimens one or two extra scales of small size are present; the last supraocular is in contact with the median scales on one side in nine specimens, on both sides in two; canthals regularly 2-2; first canthal forced above the canthal ridge in one specimen, in contact with lorilabials in six; preocular divided on one side in three specimens, on both sides in thirty-five; lorilabials reduced to one row below subocular on one side in nine specimens, on both sides in twelve; the outer row of labiomentals contacts the mental in four specimens; the inner row terminates at some point between the anterior part of the third infralabial and the anterior part of the second infralabial; auricular lobules three to five, relatively small.

The dorsal scales from occiput to base of tail vary between 28 and 35. The scales average somewhat larger in the specimens from Yucatán. The specimens from La Primavera, Guatemala, have a larger average number of scales. These specimens differ also from the others examined in possessing a larger average number of femoral pores, an azygous scale regularly present between the frontoparietals, an azygous scale much more frequently present between the prefrontals than usual, and the inner row of labiomentals terminating farther forward (even with the anterior part of the second infralabial) than usual.

The femoral pores in the entire series vary from eight to fourteen; specimens from Yucatán have the lowest average number, while the specimens from La Primavera, Guatemala, have the highest average number.

A peculiar male specimen in the National Museum (No. 46861), from Chiapas, Mexico, collected by Nelson and Goldman, is referred

to this species. It is quite possible that it represents an undescribed species; however, since certain head scales are obviously abnormal, it seems unwise to consider the specimen as representative of a new species. Its characters are as follows: snout to vent, 77 mm.; tail, 112 mm.; snout to occiput, 15.9 mm.; snout to ear, 19.9 mm.; breadth of head, 11.8 mm.; hind leg, 55.5 mm.; tibia, 15.5 mm.; fourth toe, 21.7 mm.; fifth toe, 12 mm.; lamellae fourth toe, 21-22; femoral pores, 13-14; dorsals, 31; ventrals, 47; scales around body, 36. Frontoparietals not divided; parietal one fourth size of interparietal; frontal touches interparietal; frontal not divided; supraoculars 4-4,

FIG. 6. Distribution of *Sceloporus serrifer* Cope.

three divided on each side; one row of small scales between supraoculars and superciliaries; supraoculars separated from median head scales; frontal contacts median frontonasal; latter separated on each side from lateral frontonasals by a small scale; canthals 2-2, normal; preocular divided; two rows of lorilabials, complete below subocular; outer row of labiomentals separated from mental; inner row of labiomentals terminating anteriorly even with posterior part of second infralabial.

No distinct light marks on head, except pineal spot; ventral coloration exactly as in typical *serrifer*.

Habits and habitat. Stuart (1935, p. 45) records the following notes on specimens collected at Zotz, Petén, Guatemala: "Many were seen climbing about the rafters and thatched roofs of several

Measurements and Scale Counts of *Sceloporus serrifer* Cope

Museum	MCZ	UMMZ	MCZ	MCZ	MCZ	MCZ	EHT HMS	MCZ	MCZ	MCZ	MCZ	MCZ	MCZ	MCZ	EHT HMS	EHT HMS	MCZ	USNM
Number	28159	74956	28156	28158	6269	17493	2210	6269	6269	6269	6269	28157	6269	6269	2012	2211	6269	24868
Snout to vent	81.0	82.0	82.5	82.5	83.5	89.0	89.5	90.0	91.0	91.0	92.5	93.0	98.0	101.0	101.0	109.5	112.0	102.0
Tail	.....	.....	.....	.....	100.0	.....	135.0	123.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Snout to occiput	15.3	15.8	16.2	16.0	15.5	16.6	16.7	16.5	16.8	16.2	16.0	18.0	17.4	17.7	18.0	20.0	19.2	18.2
Snout to ear	18.5	19.5	19.9	20.0	19.2	20.6	21.0	21.0	21.8	20.8	20.2	21.2	21.7	21.6	23.0	25.5	25.0	22.5
Hind leg	.....	58.5	57.5	60.0	52.0	56.0	.....	56.3	58.8	55.0	56.0	60.8	57.6	58.0	67.0	69.0	68.0	65.0
Tibia	14.0	15.1	16.0	17.0	15.0	15.5	17.0	16.0	17.0	15.8	16.0	17.0	16.0	17.5	19.0	19.5	19.9	19.0
Fourth toe	21.8	23.8	22.7	23.4	20.9	21.6	24.0	21.6	22.3	20.0	21.7	22.7	21.4	22.3	25.2	27.0	24.8	22.9
Fifth toe	12.4	13.7	13.0	12.8	11.9	13.0	14.7	12.8	12.9	11.9	11.9	13.2	12.2	12.0	14.6	15.0	15.2	13.0
Lamellae, fourth toe	20–20	20–20	20–21	20–20	19–?	16–17	22–24	17–18	18–19	19–19	19–19	20–21	18–18	20–21	23–24	20–20	20–20	20–20
Femoral pores	11–12	11–11	12–13	13–14	9–10	11–11	12–13	10–10	10–11	9–9	11–11	12–13	9–10	10–10	11–12	13–14	10–10	9–10
Dorsals	34	32	35	33	28	32	32	30	29	29	29	32	30	30	31	32	31	28
Ventrals	45	42	46	44	39	48	.....	43	39	41	41	43	41	40	.....	.....	41	43
Scales around body	33	33	32	34	33	33	35	34	32	33	31	34	35	33	34	34	32	29
Scales to head length	6.0	6.1	6.7	6.0	4.6	5.5	5.3	6.4	6.2	5.3	4.6	5.2	5.0	4.7	5.0	5.8	5.3	.....
Ratio hind leg to snout-vent	.....	71.3	69.7	72.7	62.2	62.9	.....	62.5	64.6	60.4	60.5	65.3	58.7	57.4	66.3	63.0	60.7	63.7
Ratio fourth toe to snout-vent	26.9	29.0	27.5	28.3	25.0	24.0	26.7	24.0	24.5	21.9	23.4	24.4	21.8	22.0	25.0	24.6	22.1	22.4
Sex	♀	♀	♂	♂	♀	♂	♀	♂	♂	♀	♀	♀	♀	♀	♂	♂	♂	♀

deserted houses in the small clearing. One of the adults was taken, ten feet from the ground, on the trunk of a large tree, and another which was frightened readily ascended a tree to the height of about forty feet. In actions the form appears much like *Sceloporus magister* of the southwestern United States; as an adult it is probably largely arboreal." This arboreal tendency is of considerable interest. So far as I am aware, no other species of the *torquatus* group shows the same tendency.

Distribution. Along the eastern coastal plains of Mexico and Guatemala south from southern Tamaulipas.

Locality records. Tamaulipas: Chocoy (M. C. Z. 17943, W. W. Brown). *Vera Cruz:* Papantla (U. S. N. M. 47353, E. A. Goldman); four miles east of Encero (E. H. T. & H. M. S. 2210-2). *Yucatán:* (Type locality) (Cope, 1866, 1885, 1887; U. S. N. M. 10298, 24868-74); Chichen-Itzá (Barbour and Cole, 1906); near Mérida (UMMZ 72881-90, Edwin Creaser; UMMZ 71771 [6 specimens]; MCZ 6269 [16]); Tekanto (ANSP 8500). *Guatemala:* Zotz, Petén (Stuart, 1935; UMMZ 74956 [12 specimens], L. C. Stuart); La Primavera (MCZ 28153-9, A. W. Anthony, 2500 ft.).

Remarks. The records of Werner (1896) of *serrifer* from Guatemala and Honduras may be doubted. His record from Guatemala was later (Werner, 1903) corrected.

Sceloporus torquatus torquatus Wiegmann

(Text Figs. 7 and 8; Plate XLVIII, Fig. 1)

(The following synonymy omits only those references to *torquatus* which are quite certainly wholly applicable to other species. The subspecies *torquatus melanogaster* has been included in much of the material concerning which the following papers have been written, but the uselessness of any attempt to allocate any of these with the synonymy of *melanogaster,* without examination of the specimens, is obvious.)

Sceloporus torquatus Wiegmann, 1828, p. 369; *idem,* 1834, p. 49, pl. 7, fig. 1; Fitzinger, 1843, p. 75; Müller, 1865, p. 601; Sumichrast, 1873, p. 243; Bocourt, 1874, pp. 171-173, pl. 18, figs. 9, 9a, 9b, 9c (part ?); ? Cope, 1875, p. 48; *idem,* 1879, p. 265; Sumichrast, 1882, p. 37 (part ?); Boulenger, 1885, p. 219; Cope, 1885, pp. 401-403 (part); *idem,* 1887, p. 37; Dugès, 1887, pp. 113-114; Garman, 1887, p. 14; Herrera, 1889, p. 331; Günther, 1890, pp. XII, 66; Boettger, 1893, p. 64; Herrera, 1895, p. 18; Dugès, 1896, p. 479; Boulenger, 1897, pp. 477-481, text fig. 1 (part); Mocquard, 1899, p. 156; ? Cope, 1900, pp. 336, 340, 347-350, text fig. 50; Herrera, 1904, p. 18; Gadow, 1905, pp. 194, 214 (part ?).

Tropidurus torquatus Wagler, 1830, p. 146.

Agama torquata Peale and Green, 1830, pp. 231-232; Garman, 1884, p. 17.

Tropidolepis torquatus Gray, 1831, p. 43; Duméril and Bibron, Vol. IV, 1837, pp. 301-303; Gray, 1839, p. 95; *idem,* 1845, p. 208; Aug. Duméril, 1851, p. 77; Dugès, 1870, p. 243.

Sceloporus ferrariperezi Cope, 1885, p. 400 (part); *idem*, 1887, p. 37; Günther, 1890, pp. XIII, 77; Cope, 1900, p. 335.

Sceloporus torquatus torquatus ? Cope, 1885, pp. 402, 403; *idem*, 1887, p. 37; Mertens, 1930, p. 158.

Sceloporus torquatus ferrariperezi Boulenger, 1885, pp. 220-221.

Type locality. Mexico.

Description. Head scales smooth; supraoculars in a single row, rarely (about five percent of the specimens) with the outer third or fourth of two or three separated off; two to three incomplete rows of scales separating the supraoculars from the superciliaries; one row of elongate to squarish scales between supraoculars, the first supraocular rarely touching narrowly the median head scales (2 percent); frontal normally contacting interparietal (91 percent);

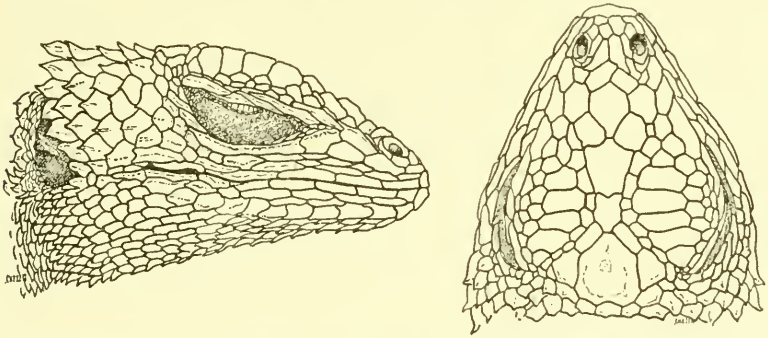

FIG. 7. Head scales of *Sceloporus torquatus torquatus* Wiegmann. EHT & HMS 3569, near Tres Cumbres (Tres Marias), Morelos; actual head length, snout to occiput, 16.3 mm.

canthals normally two (96 percent), the first frequently (about 60 percent) above the canthus, the second canthal and subnasal contacting; median frontonasal usually (66 percent) contacting the frontal, or separated from it by a small median scale between the two prefrontals; the lateral series of scales intercalated between the series of postmentals and the infralabials frequently (about 45 percent) touching the mental anteriorly; lobules on anterior margin of ear usually larger than those preceding, usually three in number, the upper two largest; median dorsal scales 26 to 30 from occiput to base of tail, in parallel series, smooth or weakly keeled, rounded or weakly mucronate; lateral dorsals somewhat larger than median dorsals, more strongly keeled and mucronate; femoral pores, 14-23 (average 18) on each side, the two series closely approximated medially; tibia approximately equal to length of shielded part of head; length of fourth toe usually a little less than distance from snout to posterior margin of ear, rarely slightly more.

Black nuchal collar always present, four or five scales long on the middorsal line; light borders of black collar one scale wide; posterior light border frequently narrowly interrupted medially, extending laterally onto the proximal end of the humerus; anterior light border usually interrupted medially, extending laterally a variable distance, sometimes to the posterior border of the ear, passing along the crest of the lateral nuchal fold, sometimes terminating at a point dorsal and anterior to the insertion of the foreleg; the anterior light border is sometimes horseshoe shaped, and extends anteriorly on each side to a point above the ear, becoming quite dim anteriorly; light borders variable in color, sometimes cream, sometimes blue or green, occasionally strongly tinged with orange; a few irregular light spots frequently present on neck; upper labial region occasionally dimly barred; back uniform olive gray, drab, olive, or blue-gray, varying according to the time elapsed since the last ecdysis; spots on back present only in some very young specimens, and when present, large and indistinct; anteroventral surface of femur usually coarsely reticulated; dorsal surface of limbs rarely banded, light bands dim and narrow when present, bluish in color; posterior surface of femur usually traversed by a light band, usually rather dim; tail with numerous, narrow, indistinct light bands, bluish or cream in color.

Ventral gular and chin region irregularly spotted or reticulated, all light areas disappearing and replaced by black or blue in adult males; no longitudinal pair of dark lines near the midventral line on the throat ever present. In some adult males, the entire ventral surface of head, body, and tail is black, with the exception of cream-colored areas on the tail and femur. In other large males the throat is pale, iridescent blue, becoming azure blue toward the neck; the neck is black, and this color is continuous with a broad, median ventral black band, occupying the chest, a wide area in the middle of the abdomen, and the groin. Usually some pale blue or cream-colored areas are visible in the middle of the abdomen. The sides of the belly are azure blue, with a generous tinge of companula blue.

In females, the belly may become drab-gray, usually darker toward the sides, and the throat usually remains gray-blue with numerous white flecks or reticulations.

Variation. The entire series is very uniform in scalation and proportions. The more important variations are given in the diagnosis. In addition, the preocular is separated from the series of scales above the supralabials in about thirty-seven percent of the

specimens; the anterior frontal is divided in about ten percent. In one specimen the frontal is not divided. Other obvious fusions of head scales rarely occur.

The coloration is very constant, within limits of variation given in the diagnosis.

Remarks. Bocourt (1874, pl. 18, fig. 9) shows the details of the dorsal head scales of Wiegmann's type of *torquatus*. The supraocular scales are exactly as in the specimens studied, in a single row, with one complete and another incomplete row of scales between them and the superciliaries. The frontal contacts the interparietal, and there is an azygous scale between the two prefrontals.

Sceloporus torquatus has been recorded from the states of Chiapas (Sumichrast, 1882), Chihuahua (Baird, 1859), Coahuila (Garman, 1887), Colima (Bocourt, 1874; Gadow, 1905), Durango (Boulenger, 1897), Guanajuato (Dugès, 1870, 1896; Boulenger, 1897), Guerrero (Boulenger, 1897; Gadow, 1905), Jalisco (Günther, 1890; Dugès, 1896; Boulenger, 1897; Mocquard, 1899), México (Peale and Green, 1830; Dugès, 1887, 1896; Herrera, 1889; Günther, 1890; Boulenger, 1897; Gadow, 1905; Mertens, 1930), Nuevo León (Yarrow, 1883; Cope, 1885), Oaxaca (Bocourt, 1874; Sumichrast, 1882), Sonora (Yarrow, 1883), Tamaulipas (Baird, 1859), Vera Cruz (Sumichrast, 1882; Cope, 1885, 1887, 1900; Boulenger, 1897) and Zacatecas (Dugès, 1896). Cope (1888) records *torquatus* from San Diego, Texas.

It is quite certain that some of these records are incorrect. Those from Chihuahua, Coahuila, Durango, Nuevo León, Sonora and Tamaulipas are almost certainly of other species. Those from Chiapas, Oaxaca and Zacatecas are doubtful, as are also some of those from Colima, Guanajuato, Guerrero, Jalisco and Vera Cruz. Cope's record from San Diego is obviously in error, probably referable to *poinsettii*.

Boulenger's (1897) records are obviously composites, as he lumped nearly all the apparently related forms, recognizing only *poinsettii*, and part of these specimens are of other forms. In his table A (single row of enlarged supraoculars) those specimens from Guadalajara, Guanajuato and Rio Santiago have characters of *torquatus melanogaster;* the one from El Paso, collected by Forrer, probably has incorrect locality data (Forrer's specimens are notable for incorrect locality data); and the remainder appear to be the only *torquatus torquatus* he had (seven specimens). In table B, the *poinsettii* from Duvall county, Texas, is peculiar in having such a

small number of scales from occiput to base of tail; the locality may be incorrect. The specimen in table B from Mexico is possibly *mucronatus mucronatus*. In table C, presumably consisting entirely of *poinsettii*, only those from Duvall county, Texas, seem to have characters of *poinsettii;* the others are very likely of other species, probably *m. mucronatus* and *m. omiltemanus*.

Habits and habitat. S. torquatus torquatus seems to be confined to areas of high elevation. Specimens I have seen or collected have been within the zone of evergreens.

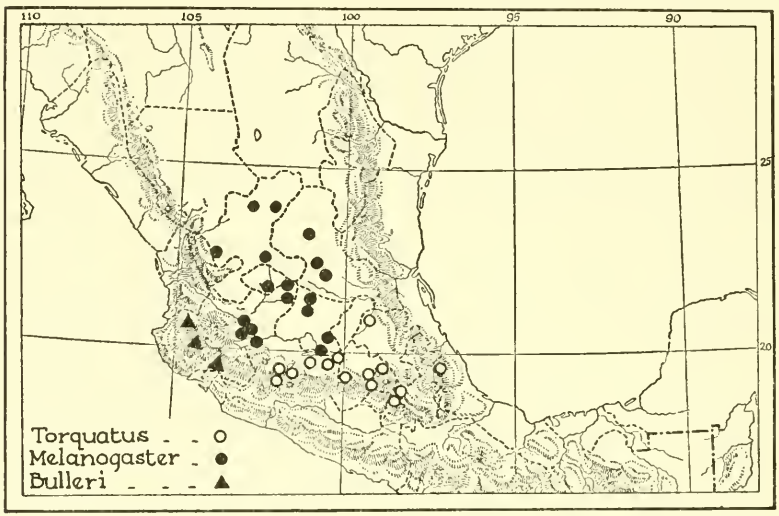

FIG. 8. Distribution of *Sceloporus torquatus torquatus* Wiegmann, *S. t. melanogaster* (Cope) and *S. bulleri* Boulenger.

In the American Museum of Natural History are eight specimens (Nos. 15540-7) which were "born in bag before May 18, 1919." The female (or females) which gave birth to the young were collected two miles west of Tacuba, D. F., by Paul D. R. R. Rüthling, on May 16, 1919.

Range. Central Mexico, including Hidalgo, western central Vera Cruz, Mexico, Distrito Federal, northern Puebla, eastern Morelos, southern Guanajuato and northern Michoacán.

Locality records. Hidalgo: Twenty-five miles south of Jacala (EHT & HMS 601-604); *México:* Two miles south of San Martín (EHT & HMS 3842); Valle de México, 7,700 ft. (MCZ 33902, W. W. Brown); Tlalpam (USNM 47769, E. W. Nelson); San Juan Teotihuacán (MCZ 16063—6, E. R. Dunn; UMMZ 63937, H. B.

Measurements and Scale Counts of *Sceloporus torquatus torquatus* Wiegmann

Number	629	3563	617	3773	3562	2784	602	3781	3383	601	3578	3772
Snout to vent	74.3	77.5	79.0	80.0	82.0	83.0	83.5	86.0	87.0	87.0	87.5	88.0
Tail	101.5	.....	105.0	.....	116.0	.....	131.0	119.0	115.0	133.0	.....	115.0
Snout to occiput	13.7	15.5	15.6	15.5	16.3	16.5	15.5	17.5	16.0	16.0	15.6	17.0
Snout to ear	17.0	18.0	18.0	19.0	20.5	19.0	18.0	20.0	20.0	21.0	18.0	20.7
Hind leg	47.6	47.0	48.0	48.0	52.0	52.3	54.0	47.6	54.0	57.0	.....	51.0
Tibia	13.5	13.3	13.7	19.7	15.0	15.0	15.0	15.0	15.0	15.5	14.5	16.0
Fourth toe	18.5	18.2	17.9	18.0	20.5	18.9	20.7	16.5	21.0	22.2	19.0	18.1
Fifth toe	9.9	10.0	10.2	10.0	10.5	10.3	11.0	10.5	11.5	12.1	10.1	10.5
Lamellae, fourth toe	20–20	19–20	19–19	18–20	20–20	20–20	19–19	17–20	20–19	19–19	20–19	19–19
Femoral pores	17–17	19–19	19–20	18–18	18–19	16–17	15–15	17–17	17–17	16–16	19–20	14–14
Dorsals	29	30	30	28	27	28	28	27	30	29	28	28
Ventrals	.....	.....	.....	50	.....	51	.....	57	55	.....	.....	44
Scales around body	35	39	40	41	41	38	33	37	38	35	36	34
Scales to head length	5.0	5.5	5.5	5.0	5.0	5.6	5.0	5.8	5.0	5.0	4.5	4.6
Ratio, hind leg to snout-vent	62.7	60.6	60.7	60.0	63.4	63.0	64.6	55.3	62.0	65.5	.....	57.9
Ratio, fourth toe to snout-vent	24.8	23.4	22.6	22.5	25.0	22.7	24.7	19.1	24.1	25.5	21.7	20.5
Sex	♀	♀	♂	♀	♂	♀	♀	♀	♀	♂	♀	♀

Measurements and Scale Counts of *Sceloporus torquatus torquatus* Wiegmann—Concluded

Number	3568	3573	3768	616	3766	3777	3775	3557	3571	3785	3842
Snout to vent	91.5	91.5	92.5	92.5	96.0	97.0	97.5	97.5	99.5	101.0	102.5
Tail	.....	.....	.....	119.0	.....	138.0	127.0	.....	122.0	140.0	.....
Snout to occiput	16.8	16.5	18.0	17.0	17.5	19.0	19.0	17.5	18.0	19.0	17.5
Snout to ear	21.0	21.0	21.8	20.3	22.0	24.0	23.0	22.0	23.2	24.0	23.0
Hind leg	57.0	55.0	60.2	60.5	58.5	61.5	63.0	.....	58.5	61.0	59.0
Tibia	17.0	16.0	17.8	16.0	17.0	18.0	18.0	17.5	17.0	19.0	17.0
Fourth toe	20.2	20.2	21.5	22.2	21.0	20.8	21.9	19.8	20.8	22.0	20.7
Fifth toe	10.2	10.4	12.0	13.0	11.7	12.1	12.3	11.0	11.0	11.7	10.5
Lamellae, fourth toe	19–20	19–19	20–21	23–23	20–19	20–21	17–17	19–19	19–20	19–18	20–20
Femoral pores	20–20	17–18	18–19	18–20	17–18	20–20	18–?	18–19	18–18	19–19	18–20
Dorsals	28	28	28	29	27	29	28	29	28	30	28
Ventrals	.....	.....	57	.....	53	53	50	.....	49	55	53
Scales around body	39	35	40	41	38	41	38	43	38	42	39
Scales to head length	5.0	5.0	5.5	5.0	4.8	5.5	5.0	4.7	5.0	5.6	5.0
Ratio, hind leg to snout-vent	62.2	60.1	65.0	64.8	60.9	63.4	64.6	.....	58.7	60.4	57.5
Ratio, fourth toe to snout-vent	22.0	22.0	23.2	24.0	21.8	21.5	22.4	20.3	20.9	21.7	20.1
Sex	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂

Baker); *Distrito Federal:* (AMNH 15490, Rüthling); Coyoacán (MCZ 9551, 9597); Pedregal de San Angel (MCZ 16090, E. R. Dunn); two miles west of Tacuba (AMNH 15540-7, Paul D. R. Rüthling); three miles west of Tacuba (AMNH 15582, Rüthling); San Juanico (AMNH 15552-4, 15592-3, 15592-7, 15603, 15605, 15608-9, 15612, Rüthling); North of Guadelupe (AMNH 15604-5, 15607, 15610, 15611, 15613, Rüthling); east of San Mateo Chalpa (AMNH 15590, Rüthling); Mexico City (USNM 12719, A. Herrera); west of Atzcoalco (AMNH 18473, Rüthling); *Michoacán:* near Uruapan (EHT & HMS 3384-90, 3765-97); near Zinapécuaro (EHT & HMS 3657, 3667, 3672-3); near Lake Cuitzeo (EHT & HMS 3723); Queréndaro (USNM 47162, 47233, E. W. Nelson); three miles north of Maravatio (EHT & HMS 3733-39); Pátzcuaro (FMNH 996 [4 spec.], 1399, S. E. Meek; USNM 20159, 20139-44, P. L. Jouy; USNM 47222, E. W. Nelson; ANSP 15358, S. N. Rhoads); Tupátaro (USNM 10238, 10244, 10232, 10235, 10252, Dugès); *Morelos:* near K63, on highway between Mexico City and Cuernavaca (EHT & HMS 1715, 1747, 1753); five kilometers south of Tres Cumbres (Tres Marias) (EHT & HMS 1689, 1691, 1693-5); near Tres Cumbres (EHT & HMS 616-624, 627-629, 3557, 3559-3581, 5115-5118). *Puebla:* near Rio Frio (EHT & HMS 3349); Atlixco (USNM 47034, E. W. Nelson). *Vera Cruz:* near Toxtlacuaya, about eighteen miles west of Jalapa (EHT & HMS 1860). *Indefinite localities:* Mexico (USNM 12095; ANSP 8499 [type of *torquatus* Peale and Green]; AMNH 15601-2); no data (AMNH 15600).

Sceloporus torquatus melanogaster (Cope)

(Text Figs. 1 and 8; Plate XLVIII, Fig. 2)

Sceloporus melanogaster Cope, 1885, pp. 400-401; *idem*, 1887, p. 37; Dugès, 1887, pp. 114-115, pl. 12, fig. 7; Herrera, 1889, p. 332; Günther, 1890, pp. xiii, 77; Herrera, 1895, p. 18; Cope, 1900, p. 335; Herrera, 1904, p. 18.

Sceloporus torquatus melanogaster Boulenger, 1885, p. 220; Boettger, 1893, p. 64.

Type locality. Cope (1885) says that the type was "probably from Guanajuato." Dugès (1887, p. 114) states: "Este escelóporo no es de Guanajuato, como lo piensa el autor, porque yo fuí el que se lo remitió sin indicación de localidad; todos los que he visto venían de México y la Noria (Michoacán), ó de Tupátaro, cerca de Cuerámaro." Type USNM 9877, Dugès collector.

Discussion. S. t. melanogaster shows no important scale differences from *torquatus torquatus.* It is notable that the dorsal scales of the latter form average very slightly smaller, are frequently almost smooth and rounded, and never more than weakly mucronate.

The supraoculars are smaller, being bounded laterally by never less than two, and sometimes three, incomplete rows of scales, and bounded medially by a row of scales more or less square in shape. In *torquatus melanogaster,* on the other hand, the dorsal scales average slightly larger and are more strongly keeled and mucronate than in *t. torquatus.* The supraoculars are larger, occasionally separated from the superciliaries by only one row of scales. The series of scales bounding the supraoculars medially are usually more elongate than in *t. torquatus.* However, so much variation occurs in these characters that they are useless for diagnosis; they are, however, of interest in general tendencies of variation, supplementing the other more diagnostic features.

In maximum size attained, *torquatus melanogaster* approaches more closely to *cyanogenys* than to any other form of the *torquatus* group; it reaches 129 mm. snout to vent, while *t. torquatus* reaches only 98 mm.

Many very striking differences in coloration are apparent. The name is quite misleading, as the belly is not as black in males of *t. melanogaster* as in *t. torquatus.* The color variation is as follows:

The black nuchal collar is not over two or three scales wide; the light borders are cream-colored, with sometimes a tinge of blue. The posterior light border is not over one scale wide, and may be quite indistinct in some specimens; it is not reduced, however, by breaking into spots, but by general decrease in distinctness. The anterior light border is quite variable, and does not extend laterally beyond a point approximately even with a line drawn posteriorly from the superciliaries. At this point it is usually continuous with a light band about one scale wide which passes anteriorly to the upper edge of the ear. This band, although sometimes quite irregular, is quite characteristic. At the point where this light band connects with the black nuchal collar, the latter is narrowed considerably and frequently completely broken. The area between these two narrow places in the black collar may be of the same color as the back, the collar confined to the shoulder region. A few light flecks usually occur in the neck region. A dark band, usually visible, passes from the upper margin of the eye to the upper margin of the ear, and is bordered below by a light band which passes underneath the eye.

The back is drab, drab-gray or glaucous-blue. A series of dim dark spots are usually present on the back, either scattered irregularly or arranged in two longitudinal rows, one on either side of the middorsal line. A few dim light spots are usually scattered

irregularly over the back. The limbs are not or but very dimly banded. The tail has dim, narrow, light bands, more distinct toward the tip of the tail.

In males, the throat is blue-gray or indigo blue, with lighter blue or whitish flecks scattered irregularly over the throat. The black nuchal collar frequently is complete ventrally. When complete, its color is continuous ventrally with a black area covering the chest, occupying a broad median area of the abdomen and extending over the groin and onto the ventral surface of the femur. When incomplete, the chest, median abdominal area and the ventral surfaces of the femora are cream. A narrow black line begins on each side of the belly opposite the axilla and extends posteriorly, covering the groin. The sides of the belly are usually pale blue, becoming campanula blue near the black borders. In lighter specimens the sides of the belly are pearl-blue.

Females have the throat much as the males, but less brilliant; the abdomen is usually uniform cream, but may have, in very large specimens, faint traces of the markings of the male. A few dim, bluish spots are usually present on the chest, and occasionally are present on the abdomen.

The very young specimens have much the same dorsal coloration of the adults, except that the pattern of dark and light spots is quite distinct. The belly is cream, and the throat is coarsely, and usually very distinctly, reticulated with bluish.

Remarks. The distinctness of *melanogaster* is quite striking, despite its close relationship with *t. torquatus*. The incomplete black nuchal collar, large size, light color and general spinosity give the general impression of the *spinosus* group.

Specimens intermediate between *t. melanogaster* and *t. torquatus* are available from a locality three miles north of Maravatio, Michoacán. In this series are two specimens which, if the black nuchal collar were broader, would be typical *t. torquatus;* in the others, the collar is broken or quite narrow laterally. In the adults of the latter, however, the belly is much blacker than it is in typical *t. melanogaster.* Specimens from other points in Michoacán seem to have affinities for *t. torquatus,* and also some from parts of Guanajuato, but the remainder are quite distinct.

It is notable that Boulenger's (1897) largest specimens of *torquatus* from Mexico are either from areas of intergradation between *t. torquatus* and *t. melanogaster,* or are well within the range of the latter.

Two female specimens in the United States National Museum (Nos. 46739-40) from Miquihuana, Nuevo León, collected by Nelson and Goldman, are referred to this species despite certain differences in coloration and femoral pore count. It is possible that these represent a race which has not been described, but for the present I prefer to retain them under the name *melanogaster* until further material is available. The specimens have the following characters (46739 and 46740, respectively): snout to vent, 79.0 and 73.5 mm.; tail, 115 mm. (46739); snout to occiput, 16.3 and 15 mm.; snout to ear, 20.1 and 18.5 mm.; breadth of head, 11.8 and 11.2 mm.; hind leg, 46.5 and 46.2 mm.; tibia, 14 and 15 mm.; fourth toe, 17.8 and 17 mm.; fifth toe, 9.3 and 9 mm.; lamellae fourth toe, 19-19 and 19-19; femoral pores, 13-13 and 12-13; dorsals, 26 and 26; ventrals, 47 and 42; scales around body, 37 and 33; scales to head length, 6.3 and 5; parietal one third size of interparietal; frontal touches interparietal; 3-4 and 2-3 small scales segmented off outer edges of supraoculars; one row of scales between supraoculars and superciliaries; none of supraoculars in contact with median scales; prefrontals in contact; two canthals, the first forced above the canthal ridge on both sides in 46739; preocular divided in 47640; rows of lorilabials reduced to one by a scale below subocular in 46739; outer row of labiomentals separated from mental; inner row of labiomentals terminating anteriorly even with the suture of the second and third infralabial.

The black nuchal collar is three or four scales broad, unbroken, with light anterior and posterior borders about one scale wide, broken medially; a few light flecks on nape of neck; a light line from subocular region to ear; another light line from posterior corner of eye to nuchal collar; limbs with indistinct bands. Ground color brown-olive, without darker markings in 46740; in 46739, the back has about four indistinct, broad, dark crossbands; the tail has narrow, distinct light bands, about nineteen in number.

Another specimen from Chapala, Jalisco (EHT & HMS 2832), assigned to this subspecies, combines certain characters of *melanogaster* and *dugesii dugesii*. The dorsals from occiput to base of tail are 38, the femoral pores are 12-13, and the lateral scales have the terminal mucrone arising slightly within the free posterior border of the scales; in these characters it approaches *dugesii dugesii*. The specimen (♀) measures 95 mm. from snout to vent and the supraocular scales are entire; in these characters the specimen approaches *melanogaster*. The general dorsal coloration is more suggestive of

d. dugesii, while the ventral coloration and character of the nuchal collar suggests *melanogaster.* It is quite possible that the specimen represents a new species. However, because of the possibility of hybridization, I prefer to consider the specimen an aberrant *melanogaster,* pending the accumulation of further material. Since typical *dugesii dugesii* and typical *torquatus melanogaster* are available from the same locality, it seems quite unlikely that this specimen indicates intergradation.

Five specimens collected by W. B. Richardson in 1893 (MCZ) and 1895 (UMMZ) at Matagalpa, Nicaragua (MCZ 6443 [4 specimens]; UMMZ 65269), are referred to *melanogaster,* with the assumption that the locality data accompanying the specimens are incorrect. A very careful comparison of these specimens with specimens of *melanogaster* from central Mexico has revealed no differences whatsoever in scale characters, with the exception that one specimen (UMMZ 65269) has a greater number of scales from occiput to base of tail (31) than normally occurs. In coloration, however, the males differ from typical *melanogaster* in having the ventral markings confined to the throat and sides of the belly; normally the chest and middle of the belly have dark markings. A young male (64 mm. snout to vent) has well-defined lateral abdominal markings. Normally no distinct markings appear in *melanogaster* of that size. The ventral scales have slipped, however, and it is assumed that this accounts for the prominence of the markings on the sides of the abdomen. The adult male (UMMZ 65269; 89.5 mm. snout to vent) has the lateral abdominal markings widely separated from each other, a condition not observed in any other specimen of *melanogaster.* It may be noted that this type of ventral coloration, with regard to the lateral abdominal markings, is typical of *serrifer* and related species. These specimens, however, are widely different from *serrifer* in many respects.

Cope's five cotypes (USNM 9874, 9876, 9878, 9880, 9895) of *ferrariperezi* purport to be from Guanajuato. If they came from that state, it seems likely that they are from the southern portion, in an area in which *melanogaster* intergrades with *torquatus.* Since Cope's specimens approach more closely in all characters to *torquatus* than to the northern subspecies, *ferrariperezi* is here considered a synonym of *torquatus.* The type of *melanogaster* (USNM 9877) is quite typical of the northern subspecies.

The haste with which Cope examined his types of *ferrariperezi* is indicated by the fact that one of them (USNM 9880) is a typical female *spinosus spinosus.*

Habits and habitat. Mr. Dunkle and I found specimens of *melanogaster* in abundance on rock fences in central Zacatecas. Certain great areas in this region are level and devoid of cliffs and canyons which the lizards probably would otherwise inhabit; as a result, the occasional rock fences were almost overcrowded. At La Colorada, Zacatecas, specimens were found in the long, deep canyons issuing from the mountains west of the town. The adults were extremely wary and difficult to approach within range of shot shells. Young specimens, born in the spring, were much more frequently seen than the adults.

Range. Northern Jalisco, west through all of Guanajuato except the extreme southern part, north through central and southern San Luis Potosí and Zacatecas. (See Fig. 8 for distributional map.)

Locality records. Aguascalientes: (FMNH 1654, C. H. T. Townsend); ten miles south of San Francisco (DHD & HMS 839). *Guanajuato:* (USNM 9877, 26137, Dugès); Celaya (FMNH 997 [2 spec.], S. E. Meek); Santa Rosa (USNM 47780, Nelson & Goldman); three miles northeast of Santa Rosa (EHT & HMS 3760-5, 3773; near Acambaro (EHT & HMS 3967, 4000, 4002-6, 4008-29); near San Felipe (EHT & HMS 4213-4227); near El Terrero (EHT & HMS 4274, 4275). *Jalisco:* (USNM 58355, J. Hurter); Calotlán (USNM 46936-41, Nelson & Goldman); ten miles west of Ojuelos (DHD & HMS 1109); near Chapala (EHT & HMS 2831, 3064-9; USNM 18971, 18975-6, P. L. Jouy); Ocotlán (FMNH 998a, 999, S. E. Meek); Florencia (USNM 46931, Nelson & Goldman); Zapotlán (FMNH 1669 [3 spec.], C. H. T. Townsend); near Jamay (AMNH 17983, 18420-9, 18474-5, Paul D. R. Rüthling); Juanacatlan (USNM 18972-4, P. L. Jouy); Atemajac (USNM 47891, E. W. Nelson); Lagos (USNM 47039, Nelson & Goldman). *Michoacán:* Querendaro (USNM 47162, E. W. Nelson). *San Luis Potosí:* (MCZ 4548, Dr. Edw. Palmer); Charcas (UMMZ 77267-77271, 77345 [27 spec.], C. L. Lundell); near San Luis Potosí (MCZ 4548 [2 spec.], Dr. Edw. Palmer); Morales (MCZ [1 spec.], W. W. Brown). *Zacatecas:* near Tiburcio (DHD & HMS 422-4, 430-454); near La Colorada (DHD & HMS 690-712, 826-836); Berriozabal (USNM 47041-2, Nelson & Goldman); Valparaiso Mts. (USNM 47871, Nelson & Goldman). *Indefinite localities:* Mexico (AMNH 17963, 17986-7, 18452; USNM 11005; USNM 25364, Dugès); Guadelupe (MCZ 6807 [2 spec.]. Comisión geográfico exploradora); Nochitongo Ditch (USNM 19004-5, J. T. Scovell & A. J. Woolman).

Measurements and Scale Counts of *Sceloporus torquatus melanogaster* (Cope)

Museum	UMMZ	EHT & HMS	EHT & HMS	EHT & HMS	DHD & HMS	UMMZ	EHT & HMS	EHT & HMS	UMMZ	EHT & HMS	EHT & HMS
Number	77271	4215	3064	3068	694	77271	3065	2831	77271	3066	4020
Snout to vent	87.0	91.0	91.5	95.0	95.0	100.0	101.0	101.0	103.0	103.0	103.0
Tail	.....	.....	112.5	.....	.....	.....	.....	.....	.....	.....	.....
Snout to occiput	17.5	17.0	17.0	17.0	18.0	18.5	19.0	18.0	21.0	18.0	19.0
Snout to ear	20.5	21.0	21.0	21.0	23.0	24.0	23.0	21.5	25.0	24.0	24.0
Hind leg	54.5	55.5	55.3	56.5	58.0	62.5	61.8	.....	66.5	60.5	.....
Tibia	15.5	16.0	16.5	17.0	17.0	17.0	18.0	17.5	19.8	17.0	20.0
Fourth toe	19.6	21.0	19.8	20.2	21.5	22.2	22.0	22.0	24.5	22.2	23.0
Fifth toe	10.0	11.1	10.8	11.0	11.0	12.0	12.7	12.0	11.8	12.5	12.0
Lamellae, fourth toe	19–20	19–19	18–19	18–18	19–19	20–?	19–20	19–?	19–20	18–19	19–19
Femoral pores	16–16	16–16	17–18	17–17	14–14	16–17	19–19	19–19	16–19	18–18	20–20
Dorsals	28	29	30	29	28	27	30	30	27	29	28
Ventrals	48	56	46	51	47	46	53	55	49	49	52
Scales around body	35	37	34	35	36	33	37	35	36	38	40
Scales to head length	5.8	5.2	5.0	5.0	5.3	5.0	5.8	5.5	5.6	5.0	5.0
Ratio hind leg to snout-vent	62.6	60.9	60.4	59.4	61.0	62.5	61.1	.....	64.5	58.2	.....
Ratio fourth toe to snout-vent	22.6	23.0	21.6	21.2	22.6	22.2	21.7	21.7	23.7	21.5	22.3
Sex	♀	♂	♀	♀	♂	♀	♂	♂	♂	♂	♂

Measurements and Scale Counts of *Sceloporus torquatus melanogaster* (Cope)—Concluded

Museum	DHD & HMS	DHD & HMS	DHD & HMS	DHD & HMS	DHD & HMS	DHD & HMS	USNM	DHD & HMS	EHT & HMS	DHD & HMS	DHD & HMS
Number	453	446	449	450	691	443	9877	669	4023	?	454
Snout to vent	104.0	107.0	110.0	113.0	119.0	121.0	121.5	123.0	127.0	128.5	129.0
Tail	.....	130.0	.....	.....	155.0	155.0	.....	.....	.....	.....	.....
Snout to occiput	19.0	19.8	19.0	19.5	19.0	21.0	21.0	20.0	22.5	22.0	22.5
Snout to ear	25.0	25.6	25.5	24.0	24.0	27.0	25.5	26.5	30.0	28.0	29.0
Hind leg	62.8	64.0	68.5	67.2	57.0	69.0	65.5	70.0	70.0	69.0	74.6
Tibia	18.5	19.0	19.5	20.0	21.0	23.2	21.0	22.0	22.5	22.0	20.5
Fourth toe	23.5	24.7	24.1	23.5	19.5	21.0	21.7	25.5	24.3	25.0	25.8
Fifth toe	12.8	12.9	13.0	13.0	13.0	12.5	12.0	12.5	13.0	13.0	13.8
Lamellae, fourth toe	19–18	19–20	18–18	20–19	18–18	18–19	17–18	19–18	20–19	19–19	19–20
Femoral pores	15–16	17–19	18–18	17–17	16–17	16–16	15–17	18–21	19–20	15–16	15–15
Dorsals	28	28	27	27	28	27	28	29	26	26	29
Ventrals	48	52	48	48	41	44	50	46	55	47	50
Scales around body	36	39	33	35	34	33	36	35	38	35	36
Scales to head length	4.8	5.0	4.4	4.5	4.0	4.2	4.0	4.4	4.3	4.2	4.0
Ratio hind leg to snout-vent	60.3	59.8	62.2	59.4	47.8	57.0	53.9	56.9	55.1	53.6	57.8
Ratio fourth toe to snout-vent	22.5	23.0	21.9	20.7	17.6	19.1	17.8	20.7	19.1	19.4	20.0
Sex	♂	♂	♀	♀	♀	♀	♀	♀	♂	♀	♀

Several specimens (Nos. 410-415) in the American Museum of Natural History purport to be from Real de Pinos, Gulf of California, collected by L. Diguet. The locality is undoubtedly incorrect.

Sceloporus bulleri Boulenger

(Text Figs. 8 and 9; Plate XLIX, Fig. 1)

Sceloporus bulleri Boulenger, 1894, pp. 729-730, pl. 48, fig. 3; *idem*, 1897, pp. 481-482.

Type locality. La Cumbre de los Arrastrados, Jalisco, Mexico.

Diagnosis. A member of the *torquatus* group; supraoculars large, in a single row; femoral pores, 14 to 19; dorsal scales, 33 to 41;

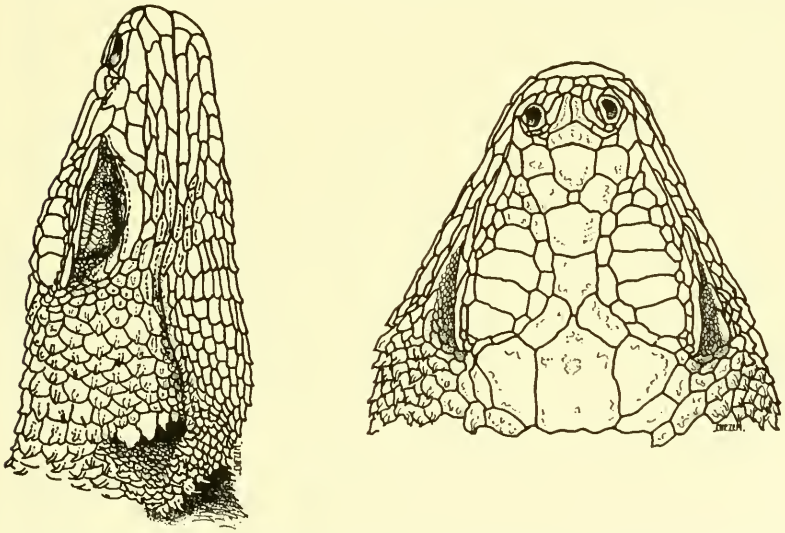

FIG. 9. Head scales of *Sceloporus bulleri* Boulenger. USNM 64655, San Sebastian, Jalisco; actual head length, snout to occiput, 19.5 mm.

fourth toe slightly less than snout-ear measurement; tibia slightly shorter than snout-occiput measurement; nuchal collar three or four scales wide, uninterrupted, with light anterior and posterior borders about one scale wide, uninterrupted; nuchal collar complete about neck in large males; sides of belly in males dark blue, black-edged.

Description (from USNM 64654, male). Head scales slightly rugose; interparietal nearly straight-sided, pentagonal; parietal single on each side, subtriangular, slightly less than one third size of interparietal; frontoparietals rectangular, narrowly in contact medially; frontal divided, the posterior section slightly more than half the size of the anterior; prefrontals narrowly in contact medially; three frontonasals, the median almost twice as large as either

lateral; internasals irregular; nasal small, round, naris pierced in middle; supraoculars five-five, separated from the superciliaries by a single row of small scales, and from median head scales by another row of small scales; canthals two-two, normal; subnasal present, large; three small loreals on one side, one on other; preocular divided; two postoculars, strongly keeled; two rows of lorilabials, reduced on one side to one row below posterior part of subocular; approximately four supralabials and five infralabials to a point below middle of eye.

Mental more or less rounded in outline, its posterior extremity pointed, with a labial border slightly more than half that of rostral; inner row of labiomentals separated from mental by a narrow contact of first postmental and first infralabial; inner row of labiomentals terminating anteriorly below anterior half of third infralabial; three pairs of well differentiated postmentals, the scales of the anterior pair in contact medially; median and anterior gular scales slightly smaller than lateral gular scales; median and posterior gular scales with one, two or three notches on free border.

Three well-differentiated auricular lobules, smooth, the lower scale pointed, the largest subequal in size to temporal scales; temporal scales weakly keeled, weakly mucronate, about one third larger than scales between ear and lateral nuchal fold; a weak dermal fold passing from upper edge of lateral nuchal fold to lower edge of ear, surmounted by strongly keeled, very strongly mucronate scales; skin in nuchal fold without scales or granules.

Dorsal scales, except those immediately behind head, keeled and with a moderately long apical mucrone and as many as four lateral mucrones on each side of the apical mucrone; lateral body scales more strongly keeled and mucronate than median dorsals, the largest subequal in size to dorsals; dorsal scales between hind legs slightly smaller than median dorsals; ventral abdominal scales about one third size of median dorsals, smooth, rounded or with a single apical notch; scales in gular fold region with as many as six apical notches; preanal scales about one third size of median ventral abdominals.

Dorsal scales of foreleg keeled and mucronate, with several lateral mucrones; dorsal scales of upper foreleg two thirds size of dorsal scales on body, about a third larger than dorsals of lower foreleg; scales on posterior surface of lower foreleg nearly as large as dorsal scales of upper foreleg; ventral scales of lower foreleg subequal in size to dorsals of same member, smooth, notched, about

twice as large as ventral scales of upper foreleg; scales in axilla squamous; lamellar formula for fingers 9-?-18-17-13 (8-14-17-17-13).

Dorsal scales of hind leg keeled and mucronate, those of thigh about two thirds size of median dorsals on body, those of shank a third larger than the former; ventral scales of tibia subequal in size to dorsals; scales about tibiometatarsal joint, except ventral scales, about one fourth size of dorsals on tibia; scales on anterior surface of femur smooth, rounded, subequal in size to dorsal scales of same member; ventral scales on femur about half as large as dorsal scales of same member, subequal in size to preanal scales; scales on posterior surface of femur subequal in size to preanal scales, strongly keeled and mucronate, strongly differentiated from dorsal scales of femur, abruptly decreasing in size posterior to femoral pore series; no postfemoral dermal pocket; lamellar formula for fingers 8-13-19-20-15 (8-13-17-21-15).

Dorsal caudal scales but slightly larger than dorsals on body; subcaudals smooth only near base of tail; enlarged postanals present, separated from each other by two small scales.

Color. General ground color, olive, darker on sides of body; no definite markings on back or limbs; nuchal collar three to four scales broad, continuous about neck in males; light borders about one scale wide, uninterrupted, the anterior border terminating at upper margin of lateral nuchal fold; posterior light border passing onto extreme proximal end of upper foreleg; no other markings on neck nor on sides of head; throat slate, with central area light blue in color in both males and females, but more distinct in the former; sides of belly blue in males, bordered medially by black, which in large males covers the chest; a small area in groin black; females with sides of belly tinged with blue and with a few irregular black areas on chest; in females a few white scales on throat; remainder of belly and ventral surface of tail white or cream.

Variation. Only four specimens of this species have been available for study. The variation in scalation of these specimens is as follows: parietals about one third size of interparietal; frontoparietals divided in none, in contact medially in two; frontal touches interparietal in two; frontal normally divided in all; supraoculars entire in all, with one complete and sometimes another incomplete row of scales between them and superciliaries (in FMNH 1670 the inner, incomplete row has two relatively large scales on one side and one on the other side); supraoculars four or five; prefrontals in

Measurements and Scale Counts of *Sceloporus bulleri* Boulenger*

Museum	BMNH	BMNH	BMNH	BMNH	USNM	BMNH	FMNH	USNM	BMNH	BMNH	BMNH	USNM
Number	.....	.....	.....	.....	64664	.....	1670	64654	.....	.....	.....	64655
Snout to vent	69.0	70.0	74.0	79.0	83.5	91.0	93.0	94.0	95.0	96.0	96.0	101.0
Tail	.....	.....	.....	.....	.....	.....	.....	138.0	.....	.....	.....	.....
Snout to occiput	15.0	15.0	17.0	17.0	17.0	19.0	17.0	19.0	22.0	21.0	22.0	19.5
Snout to ear	17.0	17.0	19.0	19.0	21.2	21.0	21.5	24.0	25.0	25.0	25.0	25.0
Hind leg	.....	.....	.....	.....	.....	.....	57.5	.....	.....	.....	.....	59.0
Tibia	14.0	15.0	16.0	16.0	15.8	18.0	15.5	.....	21.0	21.0	21.0	18.0
Fourth toe	17.0	17.0	20.0	20.0	20.0	21.0	21.6	23.0	25.0	25.0	24.0	22.5
Fifth toe	.....	.....	.....	.....	11.0	.....	11.2	12.8	.....	.....	.....	12.0
Lamellae, fourth toe	.....	.....	.....	.....	20–20	.....	17–18	20–21	.....	.....	.....	21–22
Femoral pores	15–15	15–15	15–14	15–15	15–17	15–15	13–15	19–?	15–14	18–18	17–18	17–18
Dorsals	35	35	33	38	38	36	41	41	33	39	34	40
Ventrals	.....	.....	.....	.....	53	.....	60	58	.....	.....	.....	61
Scales around body	41	44	44	44	40	42	44	42	42	44	40	43
Scales to head length	8.0	8.0	8.0	8.0	7.0	8.0	7.5	8.0	8.0	9.0	8.0	7.0
Ratio, hind leg to snout-vent	.....	.....	.....	.....	.....	.....	61.8	.....	.....	.....	.....	88.4
Ratio, fourth toe to snout-vent	24.6	24.2	27.0	25.3	23.9	23.0	23.2	24.4	26.3	26.0	25.0	22.2

* Data on British Museum specimens taken from Boulenger (1897, p. 482).

contact in two, separated by contact of median frontonasal and frontal in one, by an azygous scale in the other; canthals two, the first forced above the canthal ridge in two specimens; preocular divided on one side in one, on both sides in another; lorilabials reduced to one row below suboeular on one side of one specimen; outer row of labiomentals separated from mental in all; inner row of labiomentals terminating anteriorly between the anterior part of the third infralabial and the posterior part of the second; auricular lobules three to five, not greatly enlarged. FMNH 1670 is aberrant in having thirteen femoral pores on one side.

Boulenger (1897), who had eight specimens, states that the frontal is "sometimes in contact with the interparietal, but more usually separated from it by the frontoparietals." The dorsal scale rows are in either convergent or parallel rows. Other variations are given in the accompanying table.

Range. Known only from the western and southern parts of the state of Jalisco. (See Fig. 8 for distributional map.)

Locality records. Volcano of Colima (FMNH 1670, C. H. T. Townsend); La Laguna (USNM 64664, Nelson and Goldman); San Sebastian (USNM 64654-5, Nelson and Goldman); Colonia Brizuela (Boulenger, 1894, 1897); La Cumbre de los Arrastrados (Boulenger, 1894, 1897); Hacienda de Jalisco (Boulenger, 1897).

Sceloporus mucronatus mucronatus (Cope)

(Text Figs. 10 and 11; Plate XLIX, Fig. 2)

Sceloporus torquatus ? Gravenhorst, 1837, pp. 762-764, pl. 66, figs. 6-12; ? Sumichrast, 1882, p. 37 (part), Cope, 1885, pp. 401-403 (part); *idem*, 1887, p. 37 (part); ? Günther, 1890, pp. xii, 66 (part); Boulenger, 1897, pp. 477-481 (part); Cope, 1900, pp. 336, 340, 347-350, fig. 50.

Sceloporus torquatus mucronatus Cope, 1885, p. 402; Cope, 1887, pp. 37-38; Günther, 1890, p. 77; Cope, 1900, p. 349.

Sceloporus torquatus torquatus ? Cope, 1885, pp. 402, 403; ? Cope, 1887, p. 37.

Sceloporus torquatus poinsettii Boulenger, 1885, p. 220 (part); *idem*, 1897, p. 481 (part).

Type locality. Mirador, Vera Cruz. Cotypes USNM 25074-9, Sartorius collector. No. 25077 designated as lectotype.

Diagnosis. Dorsals, 27 to 30 from occiput to base of tail, weakly keeled, weakly mucronate, but with several lateral mucrones; upper lateral scales somewhat larger than median dorsals, more strongly keeled and mucronate; dorsal scales of body somewhat smaller than largest dorsal caudals; median ventrals about one third or one fourth as large as dorsals; scales around body, 34 to 38; head scales smooth; frontoparietals always in contact medially, or separated by an azygous scale; supraoculars always in two series; canthals irregular, usually two, the first sometimes forced above the canthal

ridge, the second canthal and subnasal contacting; femoral pores, 11-17 on each side, averaging about 13; tibia about as long as shielded part of head; length of fourth toe about equal to distance from snout to posterior margin of ear; a black nuchal collar, about four scales wide, continuous about throat in adult males; collar bordered on each side by a light band one scale wide; the posterior border sometimes continued over upper foreleg near insertion; a broad median dark band usually visible, composed of about five large, dim blotches, which are sometimes separated from each other by narrow, somewhat lighter areas; two parallel dark lines, one on either side of the median ventral line, extend from near the chin to the gular fold region; tail dimly banded; dorsal ground color olive to wood brown. In adult males, sides of the abdomen and area anterior to gular fold region caerulean or cobalt blue; gular fold region black; area anterior to this becoming darker with age, losing all trace of markings; breast, median abdominal area and region about groin black.

Description (from EHT & HMS 2092). Interparietal moderately large, about three times as large as either parietal; a parietal on each side, not much longer than broad; frontoparietals rectangular, separated medially by a single azygous scale; posterior section of frontal rectangular, about two thirds the size of the anterior section; prefrontals in contact medially; two rows of enlarged supraoculars, the scales of each approximately of equal size and not much larger than scales in the series separating the supraoculars from median head scales; two irregular or incomplete rows of scales separating supraoculars from superciliaries; median and lateral frontonasals subequal in size; internasals quite irregular; nasals and internasals separated from rostral by a single row of scales; naris pierced about in the middle of nasal, its anterior rim slightly the wider; two canthals on one side, one on other (first canthal fused with subnasal); subnasal and loreal large, latter slightly the larger; preocular divided, the upper half about one and one half times larger than lower, keeled; lorilabials in two complete rows below loreal, preocular and subocular, not imbricating; three and three fourths or four and one half supralabials to a point below middle of eye, and about five lower labials to the same point; outer labiomental series separated from mental by almost one half the length of the first infralabial; inner labiomental series terminating below middle of second infralabial on one side, below suture between second and third infralabial on other side; about six pairs of well-differentiated

postmentals, the scales of the anterior pair in contact medially. Scales of head, except in gular region, pitted, less so in the occipital, temporal, supra- and interorbital regions.

Five smooth auricular lobules, the second and third largest; scales in temporal region between eye and ear keeled, mucronate, about equal in size to scales between ear and lateral nuchal fold, which are more strongly mucronate; dorsal scales weakly keeled, moderately mucronate, with two to four lateral mucrones, more numerous in lumbar region; lateral scales similar to dorsals, some distinctly larger than median dorsals; ventrals about one third or one fourth

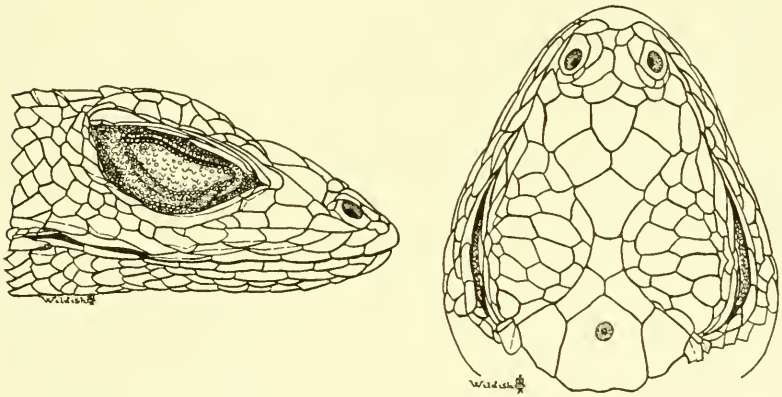

FIG. 10. Head scales of *Sceloporus mucronatus mucronatus* (Cope). EHT & HMS 2556, near Totalco, Vera Cruz; actual head length, snout to occiput, 15 mm.

as large as dorsals, rounded in pubic region, with an apical notch in the middle of abdomen and in anterior gular region, with several notches on sides of abdomen and in posterior gular region; preanals about two thirds as large as median abdominals, somewhat smaller than scales on posterior surface of femur; dorsal caudals, slightly beyond base of tail, nearly twice as large as median dorsals of body; subcaudals smooth; postanals enlarged.

Dorsal scales of humerus somewhat larger than those on lower foreleg, slightly smaller than median dorsals of body; ventral scales larger on lower forearm than on upper, smooth, notched; lamellar formula for fingers 9-14-17-16-13 (9-13-17-?-12).

Dorsal scales of tibia one and one half times as large as dorsals of femur, and distinctly larger than median dorsals on body; ventral scales of tibia larger than those on femur; lamellar formula for toes 8-12-18-18-13 (8-13-17-18-14).

Color. Head and neck slate; black collar four scales broad, with a light border one and one half to two scales wide on each side; anterior border terminating on each side between upper edges of ear and lateral nuchal fold; black collar continuous about neck; posterior light border crossing over proximal end of humerus; a series of four large, confluent, slate-colored spots of indefinite outline on middle of back, forming a broad band from light border of collar to base of tail; sides of body light olive, without darker marks; tail with narrow light bands at about every fourth whorl; limbs apparently with narrow, indistinct light bands; throat navy blue, almost black; posterior gular area, chest and a broad area down middle of abdomen black, with irregular, splotched areas of white appearing on posterior part of chest and in the median ventral line on abdomen; sides of abdomen caerulean or cobalt blue, lighter toward sides of body; median black border of lateral blue areas continuous to and covering a considerable area of the groin, and extending onto proximal anterior surface of femur; a few irregular black spots in preanal area; ventral surface of tail immaculate.

Variation. The scales of the head are essentially the same as in other species of the *torquatus* group. The supraoculars are very regular, in two rows, the outer row composed of scales but slightly smaller than those of the inner row. The scales between the enlarged supraoculars and the median head scales are very large—about half as large as the scales of the adjacent row of enlarged supraoculars. The first large scale of the inner supraocular series may fuse with a scale in the series adjacent medially, thus contacting the median head scales (occurs on both sides in seven specimens, one side in six). There are always at least parts of two rows of small scales between the outer series of enlarged supraoculars and the superciliaries. In some cases there are parts of three rows. The preocular is usually not divided (single on both sides in four specimens, one side in three). Usually the two series of scales above the supralabials are not reduced to one below the subocular (reduced on both sides in seven specimens, on one side in two). The medial of the two series of scales intercalated between the series of postmentals and the infralabials usually begins at a point about even with the suture between the second and third infralabial, although in one specimen it begins even with the suture between the third and fourth. The lateral series of these two intercalated rows begins very near the mental, but does not quite touch it, separated by less than half the length of the first infralabial. The first canthal is forced above the canthal ridge, resulting in a contact between the

second canthal and subnasal, on both sides in two specimens, on one side in two. The prefrontals are separated by an azygous scale in three specimens; the median frontonasal is invariably separated from the frontal.

Remarks. This species is related to *torquatus,* agreeing with the latter in the character of the carination and mucronation of the body scales, in the number of dorsals from occiput to base of tail, and in a number of color characteristics. It differs widely, however, in the following: Supraoculars in two rows; frontoparietals contacting on the median line; median frontonasal invariably separated from frontal; femoral pores fewer and the two series more widely separated medially; prefrontals rarely not in contact on the median line; two parallel blue lines always present on the throat; and an indistinct broad, dark band down the middle of the back. That *mucronatus* cannot be a subspecies of *torquatus* is further indicated by the fact that they exist side by side in the same locality, retaining their identity without question. Specimens of both species are in the collections from Toxtlacuaya, Vera Cruz.

The closest relationship of *m. mucronatus* is with *m. omiltemanus* (Günther), from which it differs in possessing usually a smaller number of dorsal scales from occiput to base of tail, dorsal caudals larger than dorsals on body, fourth toe usually shorter than distance from snout to posterior margin of ear, supraoculars in two even rows, and a different coloration.

Specimens of this species were found four miles east of Encero, Vera Cruz, associated with *Sceloporus serrifer.*

Cope's description of *mucronatus* was based on six specimens (USNM 25074-9) from Mirador, Vera Cruz, collected by Doctor Sartorius. Unfortunately, the cotypes have characters intermediate between *omiltemanus* and typical *mucronatus.* Typical specimens of the latter are available from the region about Jalapa, and typical specimens of *omiltemanus* are available from the region about Orizaba. Mirador is exactly between these two localities, and Cope's cotypes are very nearly exactly intermediate between typical specimens of the two subspecies. It is my conclusion that the characters of the series of cotypes as a whole approach more closely to those of the northern subspecies than to those of the southern. The color characters typical of the northern subspecies are not present, but neither are the color characteristics of *omiltemanus* present. The scale characters and proportions of the cotype correspond, on the other hand, more closely to the northern than to the southern form. Although a certain color pattern is one of the most distinc-

tive features, I prefer to consider these cotypes as belonging to the northern subspecies, since scale characters approach and since there is a possibility that the types once had color and markings not now visible which would also approach those of what I shall call typical *mucronatus*.

As first reviser, I further designate USNM 25077, a male having scale characters most closely approaching the typical, as the lectotype of *mucronatus*.

Habits and habitat. Specimens were collected in western Vera Cruz on rock cliffs at a rather high elevation above Jalapa.

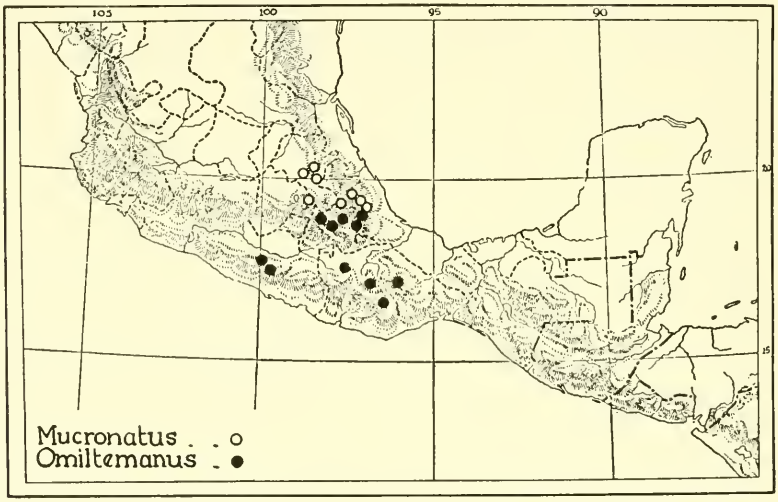

FIG. 11. Distribution of *Sceloporus mucronatus mucronatus* (Cope) and *S. m. omiltemanus* (Günther).

UMMZ 65270 contains five well-developed young, removed from the oviducts. No date is on the specimens.

Range. Parts of the states of Hidalgo, Vera Cruz, Puebla and Mexico.

Locality records. Vera Cruz: Jalapa (Cope, 1885, *et al.*); Mirador (Cope, 1885) (type locality); Las Vigas (USNM 47589-90, E. W. Nelson); Toxtlacuaya, about eighteen miles west of Jalapa (EHT & HMS 1795-7, 1859, 1861-2, 2092-8, 2130-1); Cruz Blanca (EHT & HMS 2132); four miles east of Encero (EHT & HMS 2519); near Totalco (EHT & HMS 2556, 2558, 2564, 2566-2568). *Puebla:* Fifteen miles east of San Marcos (EHT & HMS 1854-1858). *Mexico:* San Juan Teotihuacán (MCZ 1890, Dr. G. O. Rogers); ? Bay south of Mexico City (USNM 2963, I. Potts). *Hidalgo:*

Measurements and Scale Counts of *Sceloporus mucronatus mucronatus* (Cope)

Museum	USNM	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	USNM	EHT & HMS	EHT & HMS
Number	25078	2094	2564	2561	2130	2095	2131	25077	1858	2098
Snout to vent	98.0	98.0	96.5	95.5	95.0	94.0	91.0	88.0	88.0	87.0
Tail	.....	137.0	.....	113.0	.....	.....	.....	.....	110.0	.....
Snout to occiput	18.2	18.0	17.0	16.0	17.8	16.3	16.0	17.0	15.2	15.5
Snout to ear	22.5	22.5	21.1	19.5	23.0	21.0	20.3	20.7	20.2	19.5
Hind leg	60.0	61.0	56.0	53.0	60.0	58.0	55.0	59.0	54.8	54.9
Tibia	17.0	18.0	16.3	16.0	17.0	17.3	15.5	17.8	17.0	15.5
Fourth toe	20.7	22.2	18.5	17.0	21.5	22.0	19.9	21.4	19.5	21.1
Fifth toe	11.9	12.1	9.6	9.8	11.0	11 8	10.5	11.9	10.5	11.1
Lamellae, fourth toe	19–20	19.0	19.0	18.0	18.0	19.0	21.0	19–20	21.0	20.0
Femoral pores	12–13	11–11	13–13	13–15	11–12	11–12	12–13	12–13	16–17	12–13
Dorsals	30	29	29	29	28	27	30	28	30	28
Scales around body	40	37	36	36	36	37	34	36	38	36
Scales to head length	5.2	5.0	4.5	4.5	5.0	4.3	4.5	5.7	4.7	5.0
Ratio, hind leg to snout-vent	51.0	62.2	58.0	55.4	63.1	61.7	60.4	67.0	62.2	63.1
Ratio, fourth toe to snout-vent	21.1	22.4	19.1	17.8	22.5	23.3	21.8	24.3	22.1	24.2
Sex	♂	♂	♀	♀	♂	♂	♀	♂	♀	♀

Measurements and Scale Counts of *Sceloporus mucronatus mucronatus* (Cope)—Concluded

Museum	USNM	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	USNM	EHT & HMS	USNM
Number	25075	1856	2092	2559	2558	2132	25076	1862	25074
Snout to vent	86.5	86.5	85.0	83.0	80.0	77.5	77.0	75.0	74.0
Tail	.....	.....	.....	99.+	.....	.....	.....	.....	.....
Snout to occiput	16.3	15.5	16.6	15.0	14.7	15.6	15.3	15.1	14.8
Snout to ear	20.4	19.5	20.5	19.0	18.5	19.5	19.0	18.5	17.5
Hind leg	57.6	56.2	55.5	52.0	49.0	48.0	50.3	.....	48.2
Tibia	16.5	15.2	16.5	15.0	15.0	14.7	14.5	14.0	14.9
Fourth toe	21.3	20.0	20.2	18.1	17.0	19.7	19.3	18.2	17.4
Fifth toe	12.0	11.0	11.5	9.5	9.9	10.7	10.4	10.0	10.3
Lamellae, fourth toe	18–18	22	18	18	19	21	19–19	19	18–19
Femoral pores	12–13	15–15	11–12	11–12	14–14	13–14	13–13	12–?	13–15
Dorsals	31	29	28	29	30	30	30	29	30
Scales around body	37	38	37	37	37	38	34	37	37
Scales to head length	5.3	5.0	5.5	5.0	5.0	5.5	6.0	5.5	5.6
Ratio, hind leg to snout-vent	66.5	64.9	65.2	62.6	60.1	61.9	65.3	.....	64.8
Ratio, fourth toe to snout-vent	24.6	23.1	23.7	21.8	21.2	25.4	25.0	24.2	23.5
Sex	♂	♀	♂	♂	♀	♂	♂	♂	♀

(MCZ 31737); Tulancingo (USNM 47591, 47032-3, E. W. Nelson); El Chino (USNM 47291, E. W. Nelson); Guerrero Mill (MCZ 10700-5, 17114-5, W. M. Mann; UMMZ 65270 [2 spec.]); Velasco (MCZ 13651-4; UMMZ 71439 [3 spec.], 71453). *No data:* UMMZ 56487 (2 spec.).

Sceloporus mucronatus omiltemanus (Günther)

(Text Figs. 11 and 12; Plate L)

Sceloporus torquatus ? Gravenhorst, 1837, pp. 762-764, pl. 66, figs. 9-12; Bocourt, 1874, pp. 171-173, pl. 18, figs. 9, 9a, 9b, 9c (part); Sumichrast, 1882, p. 37 (part ?); Cope, 1885, pp. 401-403 (part); Günther, 1890, pp. xii, 66 (part); Boulenger, 1897, pp. 477-481, fig. 1 (part); Gadow, 1905, pp. 194, 214 (part).

Sceloporus poinsettii Bocourt, 1874, p. 173 (part).

Sceloporus torquatus torquatus ? Cope, 1885, pp. 402, 403; ? *idem*, 1887, p. 36.

Sceloporus torquatus poinsettii Boulenger, 1885, p. 220 (part); *idem*, 1897, p. 481 (part).

Sceloporus omiltemanus Günther, 1890, pp. xii, 66, pl. 32, fig. A; Boulenger, 1890, p. 78.

Sceloporus torquatus omiltemanus Taylor, 1931, p. 131.

Type locality. Omilteme, Guerrero.

Diagnosis. A species of slightly more than moderate size, belonging to the *torquatus* group; head shields smooth; supraoculars in two irregular rows; frontal rarely contacting interparietal, usually separated by an azygous scale, occasionally by contact of the two frontoparietals; laterals about one third smaller than dorsals, in oblique series; dorsals weakly keeled, mucronate, in parallel or slightly converging series, usually 30 to 38 from occiput to base of tail, rarely less than 30; laterals a little more strongly keeled and mucronate than dorsals; upper scale of auricular series extremely large, larger than preceding scales and much larger than other auricular scales; tibia about as long as shielded part of head; fourth toe as long as or slightly longer than distance from snout to posterior margin of ear; ratio of hind leg to snout-vent measurement, 61.4 to 69.7; ratio of fourth toe to snout-vent measurement, 22.3 to 26.4; black nuchal collar about four scales wide, curving slightly posteriorly, and light bordered; posterior light border complete, one to two scales wide, extending onto humerus; anterior border similar, but very short, not extending beyond lateral nuchal fold and occasionally interrupted; sides of belly cobalt blue in males, not or but narrowly and indistinctly bordered with black laterally; gular fold region black, continuous with the black of the nuchal collar; area anterior to gular fold region uniform cobalt or azure blue; dorsal caudals slightly larger than dorsals on back.

Description (from EHT & HMS 3080, male). Dorsal head shields smooth; enlarged supraoculars in two rows, the outer row formed of scales about two thirds as large as those of the inner row;

supraoculars separated from superciliaries by one complete and another incomplete row of small scales and bordered medially by a series of small scales; superciliaries five; one large, heavily keeled subocular, followed posteriorly by two small, strongly keeled postoculars; preocular scale strongly keeled, in contact with second canthal and with the rows of scales above supralabials; first canthal with a narrow downward extension which contacts the rows of scales

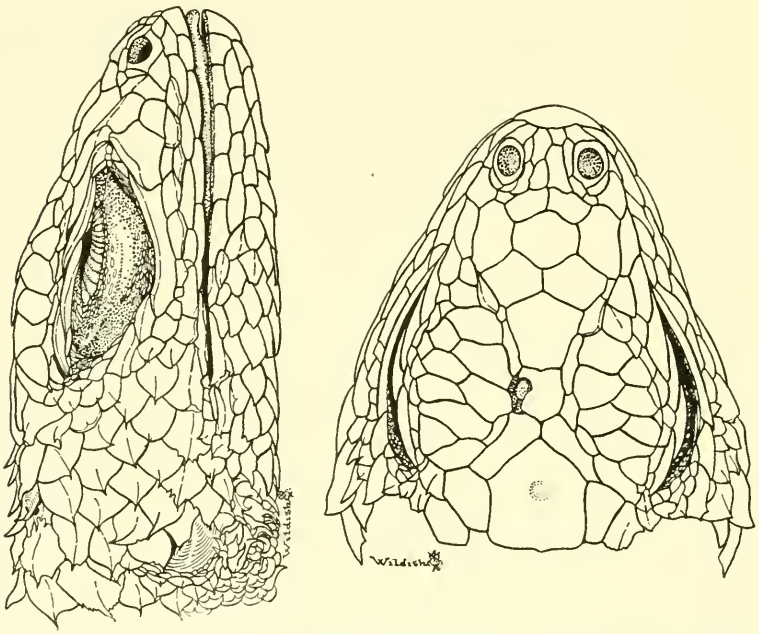

FIG. 12. Head scales of *Sceloporus mucronatus omiltemanus* (Günther). EHT & HMS 3080, two miles west of Acultzingo, Vera Cruz; actual head length, snout to occiput, 18 mm.

above the supralabials, separating the loreal from the subnasal; not quite half of second canthal forming a portion of the superciliary series; two or three irregular rows of scales above supralabials, two complete rows between the subocular and supralabials, and one row continued around snout above rostral; rostral about two and one half times as broad as high; interparietal much larger than either parietal, separated from the frontal by the frontoparietals; latter as large as parietals, in contact on median line; frontal divided, the posterior section not quite half as large as the anterior; two prefrontals, in contact on median line; three frontonasals, the laterals in contact with both canthals; internasals rather irregular, but

posterior pair distinct and separated from first canthal by a single small scale; six scales surround the nasal; four supra- and five infralabials to a point below the middle of the eye.

Mental pentagonal, its labial border four fifths that of rostal; mental followed by a series of about five enlarged scales on each side, the anterior in contact with its fellow on the median ventral line; this series of scales separated from infralabials anteriorly by a single row of elongate scales (except anterior scale, which is in contact with the first infralabial), posteriorly by two rows, the second row beginning below the junction of the second and third infralabials and in contact with the series of postmental scales; scales in temporal region keeled, mucronate in area near ear; anterior margin of ear with three smooth scales, the upper very large, much larger than other auricular scales and distinctly larger than preceding scales; lateral cervical pouch present, a fold from about its middle or upper margin to the lower margin of ear; this fold surmounted by scales somewhat larger than the adjacent ventral scales, but somewhat smaller than adjacent scales dorsal to the fold; scales surmounting this fold strongly mucronate; dorsal scales in parallel series (a small, short series intercalated on the median line), weakly keeled, mucronate, with one or two small lateral mucrones; lateral scales in diagonal rows, about one third smaller than dorsals, more strongly keeled and mucronate than dorsals, with many lateral mucrones; dorsal scales about as large as or somewhat smaller than dorsal caudals; median ventral scales about one third as large as dorsals; breast scales somewhat larger than those in median abdominal region; preanal scales somewhat smaller than the latter; anterior scales in area in front of gular fold region about half as large as the posterior scales; scales in area near angle of jaws but little larger than those in median gular region.

Dorsal scales of foreleg keeled, mucronate, those of upper foreleg about two thirds the size of the dorsals, those of lower foreleg a little more than half as large as those on upper foreleg; dorsal scales on hand weakly keeled or smooth, weakly mucronate; ventral scales on foreleg smooth, mucronate, those of lower foreleg about the same size as dorsals of the same member, those of upper foreleg becoming smaller toward axilla; one dorsal, two lateral and one ventral row of scales around fingers and toes, all continuous to tip except the two laterals which terminate behind the last scale of the other series; lamellar formula for fingers, 9-13-15-16-13.

Dorsal scales of hind limb strongly keeled, mucronate, less strongly on foot; dorsal scales of tibia slightly smaller than dorsals on body, those of femur somewhat smaller than those of tibia; ventral scales of tibia somewhat smaller than dorsals of the same member; scales on anterior surface of femur somewhat smaller than dorsals of same member, becoming progressively smaller toward femoral pore series; scales immediately in front of femoral pores about equal in size to preanal scales; scales immediately behind femoral pores very small, much smaller than those immediately in front of femoral pore series, becoming gradually smaller toward dorsal surface; lamellar formula for toes, 9-12-18-19-13; subcaudals smooth and rounded except toward distal end of tail; dorsal caudals rather strongly keeled, strongly mucronate. A pair of enlarged postanal scales.

Color. General ground color apparently drab; dorsum posterior to nuchal collar with a pattern of light lines which follow a course down the middle of each scale row, separated from each other by narrow black lines, which include the edges of the scales. The black nuchal collar is three or four scales broad, bordered anteriorly and posteriorly by a distinct whitish band one or two scales broad. The black extends over the anterior margin of the insertion of the foreleg and traverses the gular fold region ventrally. The posterior light border is complete and extends over the proximal end of the upper forearm. The anterior border is also complete and passes laterally only to the upper edge of the lateral cervical fold. The area anterior to this is blackish slate. The limbs are hair brown, immaculate. The tail is of the same color, with lighter and darker distal bands. The area anterior to the gular fold region is azure blue; the sides of the belly are somewhat darker blue, with a faint purple tinge; the chest and median abdominal region are suffused with slate, becoming black near lateral abdominal blue areas; the ventral surfaces of the forelimbs, femora and the preanal region are suffused with slate. The ventral surface of the tail is light orange toward the base, fading distally and replaced by gray.

Variation. The variation of the head scales of sixty-eight specimens is as follows: The supraoculars are almost invariably in two rows. A single young specimen from Omilteme, Guerrero (USNM 47738), is the only exception, having but a single row of enlarged supraoculars. A peculiar variation frequently occurs, however, in the series of scales normally separating the supraoculars from the median head scales. In eight specimens one or more of the enlarged

supraoculars touch the frontal (first only in three; first on one side, first, second and fifth on the other, in one; first on one side, first and second on the other, in one; first and second, in one; first, second, third and fourth [parts of each], one). The frontal touches the interparietal in five, the frontoparietals contact medially in twenty-one; and a single median scale between the frontal and interparietal is present in forty. The anterior part of the frontal is longitudinally divided in six, the posterior part in one. The preocular is separated from the row of scales above the supralabials on both sides in ten, on one side in four. The first canthal touches the lorilabials on both sides in five, on one side in three. The second canthal touches the subnasal (the first canthal above the canthal ridge) on both sides in three, on one side in five. The posterior pair of internasals contact the first canthal on both sides in seven, on one side in six. The median frontonasal narrowly contacts the frontal in two specimens, and is separated from frontal in the remainder of the series.

The length of the labial border of the mental in relation to that of the rostral varies from four fifths to a little over one half. The series of scales above the supralabials are usually two below the subocular, but occasionally reduced to one at some point below the subocular. The series of scales between the series of postmentals and the infralabials is much as in the type, except that the median of the two series begins anywhere from a point even with the junction of the first and second infralabial to a point even with the junction of the third and fourth.

The upper ear lobule is invariably larger than the other auricular scales, and larger than those preceding, except in six young specimens. The dorsal scale rows vary from parallel series to slightly converging rows.

The coloration of the adult males is much as in the specimen described. Most characteristic is the pattern of light and black longitudinal lines, which appear, so far as I am aware, in no other species of the *torquatus* group except *poinsettii*. The anterior light border of the nuchal collar is frequently broken, and the resultant spots may enclose but a single scale. The posterior light border is occasionally broken medially, and may be but one scale wide. It always extends distinctly onto the proximal end of the upper foreleg. As the specimen described is one of the largest of the series, the ventral coloration is darker than most of the other males.

Usually there is but little black ventrally, and the blue of the throat and sides of the belly is more distinct.

The dorsal coloration of the females is much as in the males, except that the longitudinal light and dark lines are less evident and are more frequently entirely absent. In these cases, small light and dark spots may be scattered over the back. In a few specimens the posterior light border of the nuchal collar is bordered behind by a very narrow black band. The ventral surface is usually whitish, sometimes with a general suffusion of blue.

In the young specimens very dim, dark bands broken medially may traverse the back. Usually the back is irregularly spotted. In only a few of the very young males are the longitudinal light and dark lines visible.

Habits and habitat. The specimens collected near Acultzingo, Vera Cruz, were found on rock cliffs on the abrupt edge of the plateau, about three fourths of the distance from the bottom. Several specimens collected on Cerro de San Luis in Oaxaca were at a considerable elevation below the evergreens.

It is assumed that *omiltemanus* is ovoviviparous, as are several other forms of the *torquatus* group, including *mucronatus mucronatus.*

Range. From central Vera Cruz in the region of Mirador south and west to the edge of the plateau in Oaxaca and Guerrero. (See Fig. 11 for distributional map.)

Locality records. Vera Cruz: two miles west of Acultzingo (EHT & HMS 3073-3080, 3082-3102, 3171-3174, 3193-3195); Maltrata (USNM 46823, Nelson & Goldman). *Puebla:* near Tehuacan (EHT & HMS 3338); vicinity of Puebla (AMNH 18815-20, Paul D. R. Rüthling); Los Reyes, near Santa Catarina (AMNH 18407, Paul D. R. Rüthling); Atzitzintla (FMNH 1516 [16 spec.], Heller & Barber, 8,500 ft.). *Oaxaca:* Cerro de San Luis, N. of Oaxaca, Oaxaca (EHT & HMS 3839-43); lower part of descent into valley of Miahuatlan (AMNH 17994-8, Paul D. R. Rüthling); Tlapencingo (USNM 47832, Nelson & Goldman); Mt. Zempoaltepec (USNM 47578-83, 47186-8, Nelson & Goldman); Tamazulapam (USNM 47325-6, Nelson & Goldman). *Guerrero:* near Chilpancingo (USNM 47830-1, Nelson & Goldman; MCZ 33903-4, W. W. Brown); Omilteme (type locality of *omiltemanus*) (Günther, 1890; Boulenger, 1897; USNM 47738, Nelson & Goldman). *Indefinite localities:* Mexico (AMNH 18400-4; USNM 31353, Boucard).

Measurements and Scale Counts of *Sceloporus mucronatus omiltemanus* (Günther)

Museum	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	USNM	EHT & HMS	EHT & HMS	EHT & HMS	FMNH	USNM	EHT & HMS
Number	3841	3843	3839	3842	3840	47831	3076	3194	3086	1516	47581	3073
Snout to vent	54.0	54.0	59.0	61.0	63.6	74.0	76.0	79.0	80.0	81.0	82.0	83.0
Tail	81.5	.....	.....	.....	102.0	106.0	124.0	.....	118.5	.....	.....	.....
Snout to occiput	11.5	12.0	12.6	13.0	13.3	14.0	14.5	14.5	14.3	15.2	15.0	16.0
Snout to ear	14.0	15.0	15.5	16.0	16.0	17.5	19.0	18.0	17.7	18.5	19.7	20.0
Hind leg	.....	37.0	.....	.....	44.2	49.0	53.0	51.5	52.5	50.2	50.0	54.0
Tibia	10.5	11.3	10.0	12.3	12.7	13.0	14.5	15.0	16.0	15.0	15.0	15.0
Fourth toe	14.0	15.6	16.3	16.9	17.8	19.0	20.1	20.2	20.0	19.0	19.0	20.2
Fifth toe	8.5	9.0	8.3	8.4	10.0	13.3	10.1	11.3	10.5	9.2	10.3	10.9
Lamellae, fourth toe	19–20	21–22	21–21	24–24	20–?	22–24	21–21	22–22	21–21	21–21	20–21	21–21
Femoral pores	15–?	15–14	15–16	14–15	11–12	11–12	15–15	13–13	13–13	13–13	11–11	13–14
Dorsals	33	37	34	36	36	30	38	32	32	34	32	36
Ventrals	57	57	54	62	58	46	52	50	49	53	47	48
Scales around body	38	40	42	42	40	34	38	37	37	40	37	39
Scales to head length	8.0	8.5	8.0	8.0	8.3	5.3	7.3	6.0	6.0	7.0	6.4	6.7
Ratio, hind leg to snout-vent	.....	68.5	.....	.....	69.5	66.2	69.7	65.1	65.6	61.9	60.9	65.0
Ratio, fourth toe to snout-vent	25.9	28.8	27.6	27.7	28.0	27.0	26.4	25.5	25.0	23.4	23.1	24.3
Sex	♀	♂	♂	♂	♂	♀	♀	♀	♀	♀	♀	♀

Measurements and Scale Counts of *Sceloporus mucronatus omiltemanus* (Günther)—Concluded

Museum	FMNH	EHT & HMS	EHT & HMS	EHT & HMS	USNM	EHT & HMS	USNM	EHT & HMS	USNM	MCZ	USNM	EHT & HMS
Number	1516	3074	3092	3094	47832	3084	47186	3079	46823	33904	47830	3080
Snout to vent	83.5	84.5	86.0	86.5	87.0	90.9	91.0	92.0	93.0	95.0	101.0	101.5
Tail	125.0	137.0	.....	.....	.....	148.0	.....	142.0	145.0	.....	.....	162.0
Snout to occiput	16.5	16.5	15.5	15.6	16.6	17.0	18.2	17.0	17.5	18.0	19.5	18.0
Snout to ear	20.0	20.5	18.5	19.8	19.7	22.0	21.0	21.5	21.6	23.0	23.0	22.5
Hind leg	57.5	.....	53.0	56.0	60.0	61.0	.....	61.0	59.0	64.2	66.5	64.5
Tibia	16.0	15.5	15.0	16.5	17.5	17.0	16.3	18.0	17.9	18.5	18.0	18.0
Fourth toe	21.7	21.6	20.5	21.5	21.7	23.0	22.6	22.5	22.3	23.6	22.6	23.5
Fifth toe	10.8	12.0	10.7	11.8	11.3	12.0	13.2	12.0	12.4	13.0	13.8	12.5
Lamellae, fourth toe	21–21	25–25	23–23	19–19	21–21	21–21	21–20	20–20	20–20	19–21	21–21	19–20
Femoral pores	13–14	16–17	14–16	11–13	14–14	14–14	11–13	15–16	14–?	16–16	14–15	13–13
Dorsals	34	34	36	33	33	35	31	37	33	32	29	32
Ventrals	54	57	57	48	52	54	42	46	56	48	49	45
Scales around body	35	39	40	36	38	38	34	38	38	36	34	37
Scales to head length	7.0	7.0	6.2	6.0	5.8	7.2	6.0	6.5	6.6	6.0	5.5	6.0
Ratio, hind leg to snout-vent	68.8	.....	63.9	64.7	68.9	67.7	.....	66.3	63.4	67.7	65.8	63.5
Ratio, fourth toe to snout-vent	25.9	25.5	22.6	24.8	24.9	25.5	24.5	24.4	23.9	24.8	22.3	23.1
Sex	♂	♂	♀	♂	♀	♂	♂	♂	♂	♂	♂	♂

Sceloporus cyanogenys (Cope)

(Text Figs. 13 and 14; Plate LI, Fig. 2)

Sceloporus torquatus cyanogenys Cope, 1885, p. 402; *idem*, 1887, p. 37 (part); Günther, 1890, p. 77; Cope, 1900, pp. 349-350; Taylor, 1931, pp. 129-132; Burt, 1932, p. 158; Stejneger and Barbour, 1933, p. 64; Mulaik, 1935, p. 156.

Sceloporus torquatus Baird, 1859, p. 5; Yarrow, 1883, p. 58 (part); Cope, 1885, p. 169 (part); *idem*, 1887, p. 37 (part).

Sceloporus torquatus mucronatus Boulenger, 1885, p. 220.

Sceloporus torquatus poinsettii (non Baird and Girard) Burt, 1932, p. 158.

Type locality. Monterrey, Nuevo León, Mexico. Cotypes USN 31373-7 and ? ANSP 11304-5; Cope collector.

Diagnosis. A member of the *torquatus* group of the genus *Sceloporus;* dorsal scales weakly keeled, mucronate, with several lateral denticulations, 32 to 40 from occiput to base of tail; lateral scales in oblique rows, somewhat larger than median dorsals; fourth toe about equal to distance from snout to posterior border of ear; ratio of hind leg to snout-vent measurement, 58.6 to 66.9; ratio of fourth toe to snout-vent measurement, 20.3 to 25.2; supraoculars irregular, not in two equal rows, rarely in a single row; median cephalic scales not extremely irregular; preocular rarely divided; inner row of labiomentals rarely terminating posterior to suture between second and third infralabials; rows of lorilabials usually not reduced to one at a point below subocular; femoral pores usually twelve or more on each side. General ground color greenish blue (brownish prior to shedding); nuchal black collar four or five scales wide, sometimes continued on ventral surface, bordered anteriorly and posteriorly by a light band one or one and a half scales wide, both interrupted medially by a dark scale; a light spot in center of interparietal and of each parietal; body without or with dim darker markings; throat and sides of belly in males pearl blue to flax flower blue or campanula blue; lateral abdominal blue areas in males with a dark-blue medial border not encroaching on anterior distal surface of femur; throat not barred or rayed.

Description (from EHT 1284 male, collected in hills north of Los Olmos Bridge, three miles south of Rio Grande City, Starr county, Texas, August 21-23, 1931). Head and body not strongly depressed; head scales with small pits, all smooth except those between supraoculars and superciliaries, between supraoculars and median head scales, and lorilabials; interparietal large, flat, shield-shaped, its posterior border extending back of parietals about one third the length of the scale; parietal single on each side, broadly wedge-shaped, about one third the area of interparietal; frontoparietals short, rectangular, in contact medially; frontal not divided (abnor-

mal); preoculars broadly in contact medially, nearly as large as median frontonasal; frontonasals about equal in size, the laterals contacting both canthals; a pair of rather large scales in front of median frontonasal; preceding these a median pair of internasals, separated from rostral by a row of small scales; nasal small, separated from rostral, naris pierced almost in the middle; five supraoculars, in one complete row on one side, three divided on other side; one complete and another incomplete row of scales between

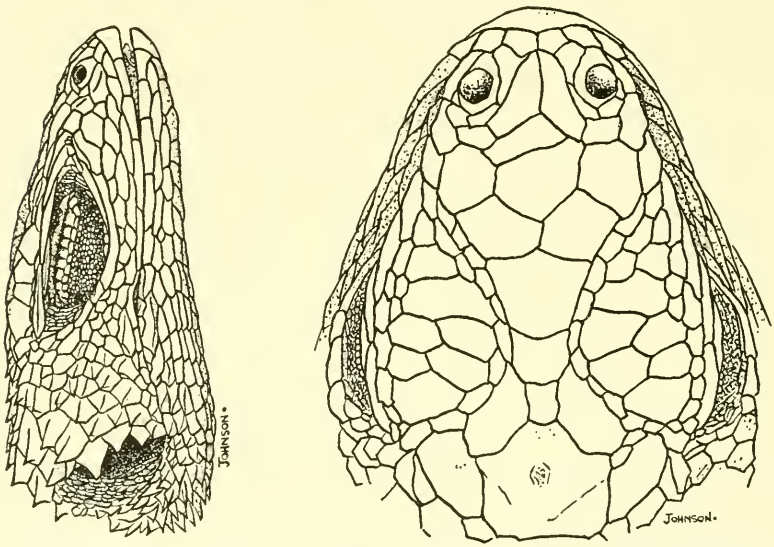

FIG. 13. Head scales of *Sceloporus cyanogenys* (Cope). EHT & HMS 4929, Arroyo Los Olmos, three miles southeast of Rio Grande City, Starr county, Texas; actual head length, snout to occiput, 16.8 mm.

supraoculars and superciliaries, the scales keeled or rugose; row of scales between supraoculars and median head scales keeled; two canthals, normal; subnasal present; two loreals, the anterior somewhat larger than posterior; preocular divided; subocular followed posteriorly by two small, strongly keeled postoculars; lorilabials in two complete rows below subocular; four upper and five lower labials to a point below middle of eye.

Mental with a labial border slightly more than half that of rostral; outer row of labiomental scales separated narrowly from mental by narrow contact of first postmental and first infralabial; inner row of labiomentals terminating anteriorly below anterior half of second infralabial; three or four well-differentiated postmentals on each side, the scales of the anterior pair in contact medially; scales in gular region approximately subequal in size, smooth,

those in the anterior part rounded, those in middle part with a single notch, and the scales in the posterior part and toward angle of jaws with two or three apical notches.

Four or five smooth, rounded auricular lobules, smaller than the preceding scales; scales in temporal region keeled, mucronate, somewhat smaller than those between ear and lateral nuchal fold; scales surmounting lateral gular fold keeled, strongly mucronate; dorsal scales weakly keeled, mucronate, with three to five lateral denticulations; lateral scales somewhat larger than median dorsals, more strongly keeled and mucronate, with as many as eight lateral mucrones; ventral abdominals about half as large as median dorsals, all with a single apical notch (except those on anterior part of chest, which have two or three); ventral scales on chest somewhat smaller than those in middle of belly; preanal scales smooth, with one or two apical notches, about half as large as median scales on belly; subcaudals smooth, mucronate, with several lateral mucrones; dorsal caudals extremely large, about one and one half times as large as median dorsals; dorsal scales between hind legs about two thirds as large as median dorsals.

Dorsal scales of foreleg about three fourths as large as median dorsals on body, those on lower foreleg about one fourth smaller than dorsals on upper foreleg; ventral scales of foreleg smooth, mucronate, denticulate, those on lower foreleg subequal in size to dorsal scales of same member, about half as large as ventral scales on upper foreleg; lamellar formula for fingers, 9-13-16-18-12 (9-13-16-17-12).

Dorsal scales of hind leg keeled, strongly mucronate, those on tibia as large as median dorsals on back, those on femur somewhat smaller; ventral scales of hind limb smooth, notched, those on tibia about two thirds as large as dorsal scales of same member; ventral scales on femur equal in size (near series of femoral pores) to preanals; scales on posterior surface of femur about twice as large as preanals, strongly mucronate, keeled, denticulate, abruptly decreasing in size immediately behind femoral pore series; lamellar formula for toes, 9-13-18- ?- ? (9- ?-17-20- ?).

Taylor (1931) has given an excellent description of the dorsal coloration:

"The color and markings of this form, while varying in certain color characteristics, maintained a striking uniformity as regards certain of the markings of the head and neck region. The typical markings are as follows: Scales on the head, brownish olive with a cream-colored spot between the supraocular regions, one on the median parietal, and one on the enlarged lateral scales adjoining the parietals; three spots on the small scales immediately

posterior to the parietal region; a broad black collar four to five scales wide medially, but narrowing laterally, extends across the scapular region, and terminates in front of the foreleg; the scales between the parietals and the posterior median edge of the black collar are from fifteen to seventeen in number; the black collar is bordered posteriorly by a greenish-yellow to cream-colored band one to one and one half scales wide which terminates laterally at the base of the foreleg; this is, almost without exception, interrupted medially by a single scale which is black or dark green; the black collar is bordered anteriorly by an irregular band of cream, or greenish or bluish-yellow, which does not extend as far on the sides as the black collar.

"The neck in front of the bands is greenish, bluish or bluish-brown with from five to seven cream or bluish-cream spots, each covering usually about two scales; the sides of the head and neck are greenish, bluish or brownish; a black spot on the head immediately behind the superciliary scales is bordered below by a lighter, usually a cream-colored spot; a cream-colored line passes from the loreal region below the eye back across the auricular region, appearing very indistinct posteriorly.

"The general body color is usually a brilliant greenish blue (often showing metallic iridescence) or (prior to shedding) brownish. On the back the markings are variable; sometimes there are a series of light ocelli or dark blackish or brownish spots; more or less distinct transverse blotches or series of spots may be present.

"Two individuals, apparently about to shed, show the brownish coloration without or only with a trace of the greenish-blue coloration. The fore and hind legs are similar to the general body color, the hind legs frequently showing some darker mottling; the coloration of the tail varies remarkably from dull brown to bluish-black with a series of 16-18 indefinite lighter bands usually one scale wide which vary from whitish to ultramarine in color; sometimes the bands are almost obsolete."

The ventral coloration of the males is most brilliant and quite different from that of other species of the *torquatus* group. The sides of the belly and the area anterior to the gular fold region are pearl to flax flower or campanula blue. In young males the blue of the sides of the belly are bordered with a narrow band of pale blue, and the center of the throat toward the gular fold region is also pale blue. In the oldest males the blue borders of the lateral abdominal patches become marine blue, and these borders expand posteriorly, covering the region of the groin. The middle of the belly is whitish, not suffused with any darker color in even the largest males. This median band is about eight scales wide. The nuchal collar extends across the gular fold region; the centers of the scales in this region may be azure blue.

The females have no markings whatsoever on the ventral surfaces. The ventral surface of the tail in both sexes is immaculate and whitish.

Variation. Details of cephalic scalation in forty-one specimens are as follows: The frontoparietals contact in six, are separated by contact of frontal and interparietal in seven, by an azygous scale in twenty-seven, and by a median pair of scales in one. The supraoculars are extremely irregular in form; in one specimen the supraoculars are entire on both sides; in another they are entire on one side; in two specimens there are two complete rows; in the remainder they are variously divided or fused. The anterior frontal is longitudinally divided in four specimens; in two the frontal is quite irregular; in another the anterior frontal is fused with one prefrontal. The prefrontals contact medially in all but two, in which they are separated by contact of the median frontonasal and the frontal. The canthals are two in all, the first not forced above the canthal ridge by contact of the second canthal and subnasal with one exception; the first canthal touches the rows of scales above the supralabials on both sides in four specimens, on one side in ten. The two rows of scales between the subocular and the supralabials are reduced to one at some point on both sides in seven, on one side in five specimens. The first pair of postmentals are separated in one specimen. The inner of the two rows of scales intercalated on each side between the series of postmentals, and the infralabials terminate even with the suture between the first and second infralabial in five cases (two cases per specimen), at the anterior half of the second in ten cases, at the middle of the second in ten, at the posterior half of the second infralabial in sixteen, at the suture between the second and third in thirty-three, and at the anterior half of the third in eight.

The auricular scales are small, the upper not greatly enlarged, occasionally slightly larger than the preceding scales.

The median dorsal scales are weakly keeled, weakly mucronate, usually in slightly or rather strongly converging rows, but occasionally in parallel rows. The laterals are slightly more strongly keeled and mucronate, and are larger than the dorsals at a point halfway between and slightly above a line from the axilla to the groin. The laterals elsewhere, toward the ventral surfaces and toward the axilla and groin, are smaller than or no larger than the dorsals. The latter are definitely smaller than the dorsal caudals near the base of the tail. The femoral pores vary from eleven to seventeen.

Habits and habitat. Taylor (1931) gives the following notes on habits:

"While collecting in Southern Texas in 1930 I kept an eager outlook for this subspecies, which resulted in its discovery. I encountered it first near Rio Grande City in the hills, one half mile to the north of the Los Olmos bridge. The specimens were extremely numerous, as many as ten or fifteen might be seen at one time running over the face of the outcropping rock which caps the hills. The largest males seemed most wary and would disappear in deep holes in or under the rocks (rather than in cracks and crevices); the larger females and the younger specimens were less wary and instead of disappearing to safety would frequently hide from sight behind a jutting rock and then expose their heads to view a moment later and allow me to approach close enough to kill them with a .22-caliber rifle using small-shot shells. It was usually necessary to wait a considerable time before the males would reappear, only to disappear again for a longer period if they chanced to see or hear me. A series of seventeen specimens were taken at this locality.

"At Arroyo El Tigre, west of Rio Grande City, the species was encountered on the dry earth banks where no rocks were to be found. They took shelter in cracks in the earth, where they were routed by causing portions of the bank to cave in. Five adult specimens were taken here.

"Eighteen miles south of Laredo I took a single specimen at Arroyo Salado. At Eagle Pass, in the cliff on the immediate edge of the town, another specimen was found. This habitat was rocky, much the same type as at Rio Grande City, but this and a single young specimen which escaped were the only specimens observed in half a day's collecting."

It is assumed that *cyanogenys* is ovoviviparous, as are other species of the *torquatus* group.

Range. Southern Texas from Devil's river southeast to Starr county, Texas, south through northern Mexico to central Tamaulipas in the east and Santa Catarina (west of Monterrey) on the west.

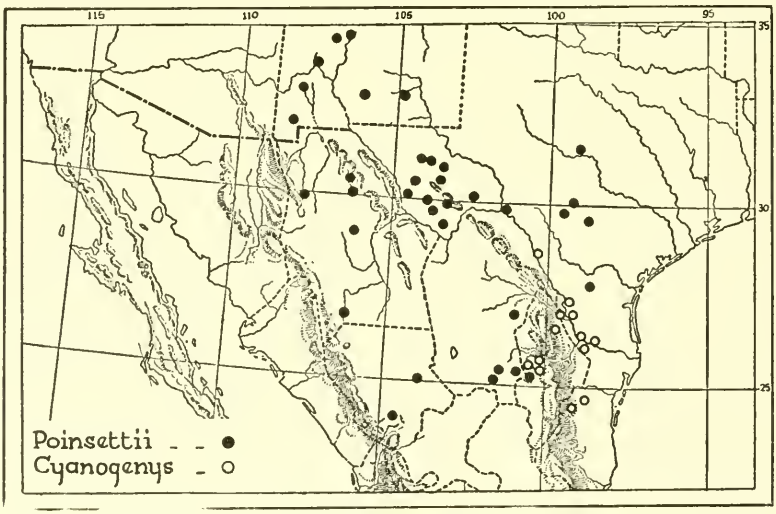

FIG. 14. Distribution of *Sceloporus cyanogenys* (Cope) and *S. poinsettii* Baird and Girard.

Measurements and Scale Counts of *Sceloporus cyanogenys* (Cope)

Museum	EHT & HMS	EHT & HMS	KU	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EH T & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS
Number	257	261	8179	260	259	4801	4720	451	256	4885	4884	4991	4803	4883	4931	4721
Snout to vent	85.0	97.0	98.0	98.5	100.0	104.0	112.0	115.0	117.0	120.0	120.5	129.0	130.0	132.0	132.0	141.0
Tail	.....	.....	140.0	.....	143.0	149.0	162.0	160.0	.....	171.0	161.0	.....	.....	.....	.....	.....
Snout to occiput	16.0	16.5	17.0	19.0	17.1	19.0	21.5	21.0	19.5	21.5	20.5	22.0	21.0	24.0	24.5	25.0
Snout to ear	20.5	21.7	22.5	23.0	22.7	18.5	27.0	27.5	26.0	27.0	27.0	29.0	28.0	30.0	32.0	31.5
Hind leg	55.0	57.0	62.5	65.2	64.0	69.0	75.0	67.5	72.0	78.0	73.0	78.5	78.0	84.5	82.0	85.5
Tibia	16.5	17.5	17.5	18.5	19.0	20.0	21.0	20.0	21.7	23.5	22.5	24.0	25.0	24.0	24.0	26.8
Fourth toe	20.5	22.0	20.0	25.0	23.5	24.0	26.5	27.0	27.0	27.5	25.0	27.0	26.5	29.3	29.0	30.0
Fifth toe	11.5	12.5	10.5	13.0	12.0	12.5	14.9	14.1	14.2	15.5	12.0	14.0	14.0	15.2	16.0	16.0
Lamellae, fourth toe	20–20	21–20	20–20	22–21	19–19	20–20	20–21	22–22	21–21	19–20	19–19	19–20	18–19	20–20	21–21	21–21
Femoral pores	13–14	13–15	12–12	14–17	14–15	12–13	15–16	12–13	13–16	12–13	11–12	12.13	13–13	14–14	13–14	12–12
Dorsals	38	38	40	39	39	34	37	39	37	37	34	35	35	34	36	37
Ventrals	52	50	54	54	54	49	52	53	47	48	49	49	54	53	54	53
Scales around body	38	43	40	45	42	39	40	42	39	38	37	42	39	43	42	42
Scales to head length	7.0	5.5	5.8	7.0	6.0	6.0	6.5	6.5	5.5	5.5	5.3	5.3	5.0	6.2	6.7	6.5
Ratio hind leg to snout-vent	64.7	58.7	63.7	66.1	64.0	66.3	66.9	58.6	61.5	65.0	60.8	60.8	60.0	63.6	62.1	60.6
Ratio fourth toe to snout-vent	24.1	22.6	20.4	25.2	23.5	23.0	23.6	23.4	23.0	22.9	20.7	22.6	20.3	22.1	21.9	21.2
Sex	♂	♀	♀	♂	♀	♀	♂	♂	♀	♂	♀	♀	♀	♂	♂	♂

Locality records. UNITED STATES: Texas, *Starr Co.:* Arroyo Los Olmos, three miles southeast of Rio Grande City (Taylor, 1931; EHT & HMS 4800, 4801, 4803, 4883-5, 4925-31, 4991, 5051-53; EHT 1 spec.; MCZ 33549); Arroyo El Tigre, west of Rio Grande City (Taylor, 1931; KU 8176-8); Rio Grande City (KU 8197-8210, 15010-21; EHT 2 spec.); five miles east of Rio Grande City (LMK 25239-40, S. Muliak); twenty miles northwest of Rio Grande City (KU 15022-3); near San Ignacio (near Rio Grande City) (EHT 4 spec.). *Zapata Co.:* near Zapata (EHT & HMS 4719-21); four miles east, one half mile south of Zapata (UMMZ 74752 [2 spec.], Helen Monroe). *Webb Co.:* Arroyo El Salado, eighteen miles south of Laredo (Taylor, 1931; KU 8180-1). *Maverick Co.:* Eagle Pass (Taylor, 1931; KU 8179; USNM 47587-8, W. Lloyd & C. P. Streator). MEXICO: *Tamaulipas:* three miles south of Nuevo Laredo, June 7, 1932 (EHT & HMS 256-264); four miles southwest of Nuevo Laredo (Burt, 1932); Mier (USNM 47715-7, 47457, W. Lloyd); between Laredo and Camargo (USNM 2959, A. Schott); Rancho El Plato, thirty-eight miles, by road, southeast of Remosá (USNM 95182, Edgar Bowles); Tamaulipaca (UMMZ 69228 [2 spec.], 69229 [2 spec.], 69230 [3 spec.], 69231 [2 spec.], 69232 [7 spec.], 69241, L. R. Dice); San José (UMMZ 69233-5, L. R. Dice); Garza Valdes (FMNH 1287). *Nuevo León:* six miles south of Sabinas Hidalgo, June 10, 1932 (EHT & HMS 447-451); Monterrey (type locality) (Cope, 1885, 1887, 1900; USNM 31373-7 [cotypes]; ANSP 11304-5 [probably cotypes; no locality given]); Caderita (MCZ 5940); Santa Catarina (USNM 4107, Lt. B. Couch); Pesquieria (USNM 2925, Lt. B. Couch).

Sceloporus poinsettii Baird and Girard

(Text Figs. 14 and 15; Plate LI, Fig. 1)

Sceloporus poinsettii Baird and Girard, 1854, pp. 126-127; Baird, 1859, p. 5, pl. 29, figs. 1-3; Cope, 1875, p. 48; Coues, 1875, p. 595; Yarrow, 1875, p. 573; Yarrow & Henshaw, 1878, p. 1645; Cope, 1880, p. 17; *idem,* 1883, p. 12; Garman, 1884, p. 17 (part); *idem,* 1887, p. 14 (part); Dugès, 1887, p. 114; Günther, 1890, pp. xii, 65; Herrick, Terry and Herrick, 1899, pp. 123-125, pl. xv; Bailey, 1913, p. 34.

Sceloporus torquatus ? Yarrow, 1883, p. 58; Garman, 1887, p. 14; Cope, 1888, p. 397.

Sceleporus poinsettii Müller, 1865, p. 602.

Tropidolepis poinsettii Dugès, 1870, p. 243 (very doubtful).

Agama torquata ? Garman, 1884, p. 17 (part).

Sceloporus poinsetti Yarrow, 1883, p. 58 (part).

Sceloporus torquatus poinsettii Boulenger, 1885, p. 220 (part); Cope, 1885, p. 402; *idem,* 1886, p. 283; *idem,* 1887, p. 37; Boulenger, 1897, p. 481 (part); Cope, 1900, pp. 340, 349, 350-352, text fig. 51 (part); Brown, 1903, p. 546; Stone and Rehn, 1903, p. 31; Bailey, 1905, p. 42; Ditmars, 1907, pp. 130, 140-141, pl. 45; Strecker, 1909, p. 13; Strecker, 1915, p. 20; Stejneger and Barbour, 1917, p. 56; Van Denburgh, 1922, pp. 326-329; Stejneger and Barbour, 1923, p. 59; Van Denburgh, 1924, pp. 206-207; Strecker, 1927, p. 14; *idem,* 1928, p. 12; Taylor, 1931, pp. 130-131; Mosauer, 1932, pp. 7-8; Stejneger and Barbour, 1933, p 65; Strecker, 1933, p. 78; *idem,* 1935, p. 32.

Type locality. "Rio San Pedro of the Rio Grande del Norte, and the province of Sonora." Cotypes USNM 2948 (2 spec.) and 2952 (2 spec.); J. H. Clark, collector.

Diagnosis. A member of the *torquatus* group of the genus *Sceloporus*, possessing a broad, black nuchal collar two and one half to three scales broad, uninterrupted medially, with broad, light-colored borders about two scales wide; tail very strongly banded, the dark bands wider than the light bands and extending completely around tail near tip; general color, straw to reddish yellow; back frequently with broad bands; dorsals, 31 to 41 (average 35.7) from occiput to base of tail, nearly smooth, not or but weakly mucronate; supraoculars in two complete rows; median cephalic scales usually very irregular; the anterior frontal usually divided; preocular rarely divided; inner row of labiomentals rarely terminating anterior to suture between second and third infralabials; lorilabials usually reduced to one row at some point below subocular; femoral pores usually not over 12; maximum snout-to-vent measurement, about 120 mm.

Description (from DHD & HMS No. 105, male). Head somewhat compressed; dorsal and lateral cephalic scales rather strongly pitted; parietal single on each side; interparietal pentagonal, about three times as large as either parietal; frontoparietals divided; an azygous scale separating frontoparietals medially; posterior section of frontal about one half the size of anterior section of frontal; a small scale between frontal and frontoparietals on one side; anterior section of frontal longitudinally divided; prefrontals separated medially by an azygous scale, which is wedged deeply between either half of anterior section of frontal; median frontonasal wedged deeply between prefrontals, separated on one side by a small scale from lateral frontonasal; scales in internasal region quite irregular; nasal (and internasals) separated from rostral by a row of small scales; anterior rim of nasal much broader than posterior rim; supraoculars about six, in two rows, the scales subequal in size; supraoculars separated from median cephalic scales by one complete row of scales, and separated from superciliaries by one complete and another incomplete row of scales; two canthals, the anterior not forced above canthal ridge; one subnasal, small; loreal single, somewhat larger than subnasal; preocular not divided; subnasal short, followed by two small, strongly keeled postoculars; lorilabials in two rows, reduced to one at a point near posterior end of subocular; supralabials about four, infralabials six, to a point below middle of eye.

Mental more triangular than pentagonal in shape, with a labial border almost equal to that of rostral, postmentals poorly differentiated, about five pairs discernible, the scales of the anterior pair in contact; outer row of labiomentals narrowly separated from mental by a narrow contact of first postmental and first infralabial; inner row of labiomentals terminating below middle of third infralabial; scales in gular region about half as large as median ventral abdominals, about equal in size to preanals; gular scales en-

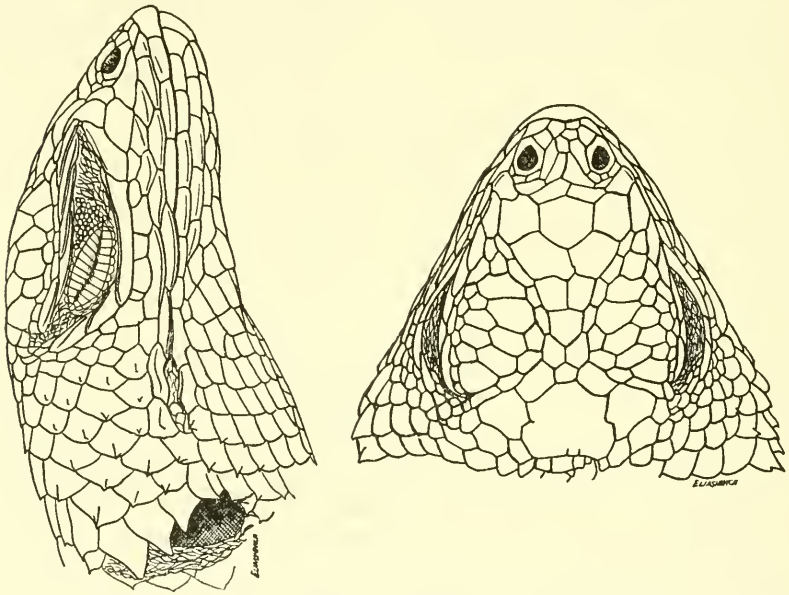

FIG. 15. Head scales of *S. poinsettii* Baird and Girard. DHD & HMS 1142, 30 miles west of Monterrey, Nuevo León; actual head length, snout to occiput, 17 mm.

tire anteriorly, with a single median notch posteriorly, and with two notches laterally at posterior part of throat.

Three or four well-differentiated auricular lobules, smooth, acuminate, smaller than preceding scales; scales in temporal region weakly keeled, weakly mucronate, with a few lateral mucrones; lateral nuchal fold not extremely deep, surmounted by very long, strongly acuminate, keeled scales; dorsal scales of neck and body smooth or very weakly keeled, not acuminate, but with several mucrones at free end; lateral scales weakly keeled, mucronate, with numerous lateral denticulations, arranged in oblique rows; median lateral scales distinctly larger than median dorsals; scales between bases of hind legs one half to one third as large as median dorsals on back; dorsal caudal scales weakly keeled, strongly mucronate,

those near base of tail distinctly larger than median dorsals on back; median ventral scales one fifth or one sixth as large as largest laterals, with a weak median notch; scales at extreme anterior portion of breast larger than scales posterior; subcaudals smooth; postanals distinctly enlarged, separated by two small scales.

Dorsal scales of foreleg subequal in size, those of humerus somewhat the larger, all slightly smaller than median dorsals of back, weakly keeled, rather strongly mucronate, with several lateral denticulations; ventral scales of lower foreleg subequal in size to dorsal scales of same member, about three or four times as large as ventral scales of humerus; ventral scales of foreleg smooth, acuminate; lamellar formula for fingers, 9-13-15-17-11 (8-12-15-16-12).

Dorsal scales of tibia somewhat larger than those on femur, subequal in size to dorsal scales on body; dorsal scales of hind leg weakly keeled, strongly mucronate, with several lateral mucrones; ventral scales of hind leg smooth, rounded or notched, those on tibia slightly smaller than dorsals of same member, those on femur much smaller, the smallest about equal in size to preanal scales; scales on posterior surface of femur four times as large as preanals, keeled, strongly mucronate, abruptly becoming quite small immediately posterior to femoral pore series; no postfemoral dermal pocket; lamellar formula for toes, 9-11-16-18-13 (8-11-15-17-13).

Color. General ground color, above, straw yellow; head reddish-brown above; black nuchal collar about three scales wide, bounded on either side by a light band two scales wide, each very narrowly interrupted medially; anterior light border terminating on each side between ear and foreleg; posterior border terminating at axilla, not crossing onto shoulder; a light band about two scales wide across neck halfway between nuchal collar and occiput, terminating at upper edge of ear; a broad light line down each dorsal scale row, one separated from the other by a narrow black line involving the lateral edges of each scale row; these lines terminating at base of tail; about five faint dark bands across back, separated from each other by slightly narrower lighter bands; these bands very distinct on tail, the darker bands (reddish-brown in color) about two and one half scales wide, the lighter bands (straw yellow in color) about one and one half scales wide; dark bands completely encircling tail near tip; limbs straw yellow, with no evidence of markings.

Chest cream, with dark gray flecks; black nuchal collar complete across ventral surface of neck, but very narrow; throat uniform caerulean blue, not barred; sides of belly pale to caerulean blue, bordered medially by a black band which posteriorly involves a

considerable area in groin and passes onto proximal portion of femur, and anteriorly becomes narrower and disappears about one fourth of the distance from the axilla to the groin; preanal region pale blue, with flecks of black; ventral surfaces of limbs pale yellow.

Variation. Detailed data on the character of the head scales of fifty-two specimens from all parts of the range of the form show the following variation: Frontal never contacting interparietal; frontoparietals contacting medially in fourteen; an azygous scale separating frontoparietals medially in thirty-five (frontoparietal and frontal scales indistinguishably broken up in the other three specimens); frontoparietals divided into two on both sides in twenty specimens, and on one side in thirteen; the anterior frontal is divided longitudinally in thirty-eight specimens; the posterior frontal is divided longitudinally in five specimens, broken into three sections in seven specimens, into four sections in four, and into five sections in one; the parietal and frontoparietal of one side are fused in one specimen; the supraoculars are usually in two rows, the outer composed of scales smaller than the inner; in seven specimens the outer row is represented by two or three scales segmented from the inner row, and do not form a complete outer row as in the others; one enlarged supraocular narrowly contacts the median head shields on one side in three specimens, on both sides in one; the row of scales separating the supraoculars from the median head shields is supplemented by the addition of one, two or three small scales, forming an incomplete inner row, in eight specimens; the prefrontals contact medially in thirty-seven specimens, are separated by contact of the median frontonasal with the frontal in two specimens, and are separated by an azygous scale in twelve; the preocular is separated from the rows of scales above the supralabials on both sides in four specimens, on one side in four; the two canthals are present in all, the first forced above canthal ridge by contact of second canthal and subnasal on both sides in three specimens, on one side in four; the anterior canthal touches the rows of scales above the supralabials on both sides in five specimens, on one side in two; the posterior canthal touches these rows in one specimen; the rows of scales below the subocular and above the supralabials are reduced to one at some point on both sides in thirty-eight specimens, on one side in four; the inner of the two series of scales intercalated between the rows of mentals and the infralabials continues forward usually to about even with the anterior half of the third infralabial (on one side in nineteen, on both sides in twenty-two); on one side in two specimens it extends to the middle of the second infralabial; on one side in two, to the posterior part of the sec-

ond; on one side in six, to the suture between the second and third; on both sides in one and on one side in five, to the middle of the third; on one side in three, to the posterior part of the third; on one side in six and both sides in one, to the suture between the third and fourth; on one side in eight and both sides in one, to the anterior part of the fourth; on one side in one, to the middle of the fourth; on one side in one, to the middle of the fifth.

The dorsal scale rows are sometimes parallel, sometimes converging (two or three rows lost in eleven specimens, one in ten). In two the rows are actually diverging, a row being intercalated at about the middle of the back and continuing to the base of the tail. In several (four noted) the rows diverge anteriorly and converge posteriorly, a short median row being intercalated.

The median lateral scales and the caudals near the base of the tail are distinctly larger than the median dorsals in all.

Preceding the anus males frequently have several modified scales appearing somewhat porelike.

The scales on the anterior margin of the ear are usually smaller than those preceding them; only rarely is the upper scale slightly larger.

The coloration is quite uniform and very characteristic. In no other species of the *torquatus* group are the dark and light bands about the tail so distinct. Toward the tip of the tail the bands are visible upon the ventral caudal surface (not in *cyanogenys*). Other characteristics of the dorsal coloration are, likewise, distinctive. The nuchal collar is always complete, and about three scales wide. It is bordered anteriorly and posteriorly by a light band about two scales wide, the anterior of which extends laterally to the lateral nuchal fold, and the posterior to the upper margin of the insertion of the foreleg, but not passing onto the leg. Either or both light borders rarely may be broken medially, but are never broken into spots or appear as narrow bands. The black collar may extend across the gular fold region, uniting ventrally. Anterior to the nuchal collar is a light band about two scales wide across the posterior part of the head, passing laterally to the upper edge of the ear. This band may be broken into spots, but usually is distinct and complete. A light band, usually visible, passes from the upper labial region to the anterior margin of the ear.

Frequently, more often in males, there are light bands which pass down the back along the middle of each longitudinal scale row, separated from each other by narrow black bands. This type of color-

ation occurs also in *mucronatus omiltemanus*. The females frequently lack this and may also have irregular and indistinct dark spots on the back.

In males, the sides of the belly and the gular region are caerulean blue, becoming darker with increased age. The sides of the belly may become somewhat tinged with purple, and the gular region marine blue, which increases in intensity posteriorly toward the gular fold region. The blue of the sides of the belly is bordered medially by a rather narrow black band, which expands posteriorly and covers the entire area of the groin. The median abdominal area is whitish, suffused with black in older males.

The gular region in females is irregularly marked with black.

Habits and habitat. This species seems to be confined entirely to a rocky habitat. In Texas and New Mexico they are found on limestone bluffs in considerable numbers, and are difficult to capture. Not only does their color, except for the brilliantly banded tail, blend well with the color of the rocks, but they are exceedingly wary, diving into cracks or under rocks at the first sign of danger. Once hidden in cracks, it is only with the greatest difficulty that they can be routed. Rarely are they discovered before they have hidden under rocks or in cracks.

In Durango and Chihuahua specimens were secured on red granite ledges, where the lizards assumed a reddish hue quite similar to the color of the rocks.

The species is ovoviviparous, as is indicated by a female in the Museum of Zoölogy of the University of Michigan (No. 49846). This specimen, collected May 31, 1916, contains ten well-developed embryos. The young are presumably born during the early part of June.

Remarks. The characters which distinguish *poinsettii* from *cyanogenys* are numerous, although for the most part minor. No intergradation between the two forms has been observed in the specimens examined, specimens of each form remaining quite distinct in the areas of closest approach of their respective ranges. The type locality of *cyanogenys* is Monterrey, Nuevo León, and specimens of typical *poinsettii* are available from a locality thirty miles west of Monterrey. In Texas, specimens of *poinsettii* are available from the mouth of the Pecos river, Valverde county (and the type locality, in part, is Devil's river), and specimens of *cyanogenys* from Eagle Pass, Maverick county, not over seventy miles away.

Aside from color differences, which are quite striking and constant both in live and preserved material, *poinsettii* is to be distinguished

from *cyanogenys* by the following points: supraoculars usually in two complete rows, the inner row seldom incomplete and never lacking; median cephalic scales usually very irregular, the anterior frontal usually divided; the preocular rarely separated from the rows of scales above the supralabials (10 in 96 in *poinsettii*, 60 in 78 in *cyanogenys*); the medial of the two rows of scales between the postmentals and infralabials terminating farther posteriorly (in 9 counts of 96 in *poinsettii* the row extends anterior to the suture between the second and third infralabials; in *cyanogenys*, only 6 in 78 have the row extending posterior to that suture); the rows of scales between the subocular and supralabials rarely not reduced to one at some point (84 out of 96 in *poinsettii* have the rows reduced to one; in *cyanogenys*, 16 in 76); femoral pores usually fewer. The maximum size is also much greater in *cyanogenys*, the latter reaching 143 mm. snout to vent, *poinsettii*, 118 mm. (KU 8185).

Range. Southern New Mexico east to central Texas, south through western Nuevo León and southern Coahuila to central Durango. (See Fig. 14 for distributional map.)

Locality records. United States: New Mexico: *Eddy Co.:* Guadalupe Mts. (Mosauer, 1932; KU 14996), Guadelupe Mts., forty-four miles northwest of Carlsbad (AMNH 46389, Barnum Brown), Dark Canyon, Guadelupe Mts. (MCZ 31728-9); *Grant Co.:* Santa Rita del Cobre (Cope, 1900; Van Denburgh, 1922), Hachita (Van Denburgh, 1922), Gatton's Park (LMK 24280-3, D. O. Scott); *Lincoln Co.:* Forks of Ruidoso Creek (Van Denburgh, 1922); *Otero Co.:* Alamogordo (Van Denburgh, 1922), Sacramento Mts. (ANSP 15163, Rehn & Viereck); *Sierra Co.:* Chloride, Grafton (Van Denburgh, 1922); *Socorro Co.:* Magdalena Mts. (Herrick, Terry and Herrick, 1899; Van Denburgh, 1922), Socorro (Cope, 1883; Van Denburgh, 1922). Texas: *Bexar Co.:* (Strecker, 1927); Helotes (Taylor, 1931; Strecker, 1933; KU 8174-5); San Antonio (AMNH 44411, R. B. Parks). *Brewster Co.:* (Strecker, 1909); Chisos Mts., 6,000 ft. (Bailey, 1905); fifty miles south of Marathon (Bailey, 1905); Glass Mts., five miles south of Marathon (KU 15009, 15001-4); three miles southwest of Alpine (Taylor, 1931; KU 14993-4, 15131, 15133, 15137-40); six miles west of Alpine (Taylor, 1931); Alpine (KU 8182-94); fourteen miles north of Terlingua (Taylor, 1931, KU 8166-8168; EHT 2 spec.). *Culberson Co.:* Guadalupe Mts. (Bailey, 1905; Mosauer, 1932). *Brown Co.:* San Saba river, south of Brownwood (H. M. Smith). *Duvall Co.:* (Boulenger, 1897); San Diego (Cope, 1900; Strecker, 1915). *Jeff Davis Co.:*

six miles east of Valentine (KU 14998-15000); Davis Mts. (KU 18422), Davis Mts., 5,700 ft. (Bailey, 1905); Phantom Lake (UM MZ 49846, H. T. Gaige). *Kerr Co.:* Japonica (Bailey, 1905). *Pecos Co.:* Pecos (Stone and Rehn, 1903; ANSP 15768-84, A. E. Brown); fifty miles southwest of Pecos (Brown, 1903); Fort Stockton (Bailey, 1905). *Presidio Co.:* Paisano (Bailey, 1905). *Real Co.:* West Frio Canyon (Strecker, 1935). *Reeves Co.:* near Toyah (Bailey, 1905); Waihnacht's Draw, Pecos Valley (MCZ 31745). *Terrell Co.:* Between Dryden and Sanderson (KU 15005-8). *Valverde Co.:* Rio San Pedro of the Rio Grande del Norte (now Devil's river) (Baird and Girard, 1854; Yarrow, 1883; Cope, 1900; USNM 2948 [2 spec.], J. H. Clark [cotypes]); five miles east of mouth of Pecos river (KU 14995); near mouth of Pecos river (KU 14997).

MEXICO: *Chihuahua:* (Cope, 1887, 1900; USNM 14233, 14243); Ojo Caliente (Yarrow, 1883; Cope, 1900; USNM 2958); Chihuahua City (Cope, 1886); ten miles south of Moctezuma, June 20, 1934 (DHD & HMS 104-113); eighteen miles north of Escalón, June 25, 1934 (DHD & HMS 246-256); Colonia Garcia (ANSP 1, Dr. W. E. Hughes); Sierra Madre (USNM 47419-21, Nelson and Goldman); Balleza (USNM 47417, Nelson and Goldman); Casas Grandes (FMNH 1655, C. H. T. Townsend); Samachique (FMNH 11841-7, 15724 [18 spec.], R. M. Zingg); Arroyo del Alamos (USNM 42873, E. C. Erdis). *Coahuila:* Monclova (Garman, 1887; USNM 46699, Nelson & Goldman); Santa Caterina (Cope, 1900); fifteen miles east of Saltillo, July 31, 1934 (DHD & HMS 1141); Sierra Guadelupe (USNM 47591-2, Nelson and Goldman); Jaral (FMNH 1547, Heller & Barber). *Durango:* (MCZ 16030, P. Townsend; USNM 23992, Dr. E. Palmer); Ciudad (Günther, 1890; Boulenger, 1885, 1897); six miles northeast of Pedriceña, August 27, 1932 (EHT & HMS 4361, 4362, 4364-4371); near Pedriceña, August 29, 1932 (EHT & HMS 4456-4470); near Pasaje, August 28, 1932 (EHT & HMS 4456); Coyotes (FMNH 1510 [10 spec.], Heller & Barber); Durango (USNM 46844-5, Nelson & Goldman). *Nuevo León:* thirty miles west of Monterrey, July 31, 1934 (DHD & HMS 1142).

The above locality records appear to be reasonably correct. There are many more which do not so appear. They are from Arizona (Coues, 1875; Yarrow, 1875, 1883; Yarrow and Henshaw, 1878; Cope, 1900; MCZ 6831 [Flagstaff?]); California (Boulenger, 1895; KU 11383); Colima (Bocourt, 1874); Guerrero (Boulenger, 1897); Jalisco (Dugès, 1870); Mexico (Dugès, 1887); Michoacán (Dugès, 1887); Oaxaca (Bocourt, 1874); San Luis Potosí (Garman, 1887);

Measurements and Scale Counts of *Sceloporus poinsettii* Baird and Girard

Museum	DHD & HMS	DHD & HMS	EHT & HMS	KU	EHT & HMS	DHD & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS
Number	252	254	4467	8175	4469	111	4460	4362	4464	4461
Snout to vent	69.0*	72.0	80.0	81.0	85.0	86.0	89.0	90.0	91.0	91.0
Tail	103.0	.....	.....	.....	.....	111.0	.....	.....	137.0	.....
Snout to occiput	13.8	13.5	15.0	16.3	16.0	15.5	16.0	15.0	17.0	16.0
Snout to ear	17.0	17.5	19.0	20.0	20.5	19.5	20.0	19.0	21.0	20.0
Hind leg	47.5	43.0	54.0	51.5	55.5	53.0	57.0	54.0	61.0	56.5
Tibia	13.5	12.5	15.0	15.5	16.0	16.0	17.4	15.5	19.0	17.0
Fourth toe	17.0	16.2	17.5	18.3	20.0	18.5	19.9	19.0	22.0	20.0
Fifth toe	9.0	8.5	9.9	10.7	11.0	9.9	11.0	9.5	11.0	12.0
Lamellae, fourth toe	20–20	16–17	17–17	18–19	18–18	16–18	18–18	17–17	18–19	18–18
Femoral pores	10–11	10–11	11–12	11–11	14–14	11–12	10–11	10–10	9–10	11–11
Dorsals	40	41	36	35	38	33	36	36	37	38
Ventrals	56	54	51	52	58	55	49	54	48	54
Scales around body	41	43	34	37	39	38	37	41	39	38
Scales to head length	8.0	8.0	6.5	7.0	7.0	6.5	6.7	6.0	6.0	7.0
Ratio, hind leg to snout-vent	68.8	59.7	65.0	63.5	65.2	61.6	64.0	60.0	68.6	65.3
Ratio, fourth toe to snout-vent	24.6	22.5	21.8	22.5	23.5	21.5	22.3	21.1	24.1	21.9
Sex	♂	♂	♀	♂	♂	♂	♀	♀	♀	♂

* Back broken.

Measurements and Scale Counts of *Sceloporus poinsettii* Baird and Girard—*Concluded*

Museum	EHT & HMS	DHD & HMS	EHT & HMS	DHD & HMS	DHD & HMS	KU	KU	KU	DHD & HMS
Number	4463	112	4462	1141	1142	8174	14995	14997	105
Snout to vent	94.0	95.5	95.5	96.5	97.0	108.0	110.0	110.0	112.0
Tail	.....	.....	.....	.....	.....	.....	148.5	.....	.....
Snout to occiput	16.5	17.5	17.5	17.0	17.0	19.0	18.5	19.5	19.5
Snout to ear	22.0	21.5	23.0	21.0	21.5	24.0	25.0	24.5	23.5
Hind leg	58.0	57.0	58.0	58.0	61.0	67.5	.....	70.0	65.0
Tibia	18.0	17.0	17.5	16.8	19.0	20.0	20.0	20.0	16.5
Fourth toe	20.2	20.0	20.5	20.0	22.0	23.7	22.9	25.0	21.5
Fifth toe	10.7	11.0	10.5	10.7	11.4	13.0	13.3	13.5	11.5
Lamellae, fourth toe	19–19	19–20	18.18	19–19	20–19	18–18	19–19	20–20	17–18
Femoral pores	11–11	11–12	10–11	12–12	10–10	11–11	10–12	13–14	9–11
Dorsals	34	33	34	33	33	34	36	36	35
Ventrals	51	52	51	49	55	57	60	58	55
Scales around body	35	38	37	38	39	39	39	41	37
Scales to head length	6.0	6.0	6.0	6.0	6.0	6.0	5.7	6.0	5.5
Ratio, hind leg to snout-vent	61.7	59.7	60.7	60.1	62.8	62.5	.....	63.6	59.6
Ratio, fourth toe to snout-vent	21.4	20.9	21.4	20.7	22.6	21.9	20.8	22.7	19.1
Sex	♀	♂	♂	♀	♀	♂	♂	♂	♂

Sonora (Baird and Girard, 1854; Baird, 1859; Yarrow, 1883; Garman, 1884; Cope, 1900; Van Denburgh, 1922; USNM 2970, Col. Graham; USNM 2952 [2 spec.], J. H. Clark [cotypes]); Tamaulipas (Burt, 1932); and Vera Cruz (Boulenger, 1885, 1897).

Sceloporus lincolateralis Smith

(Text Figs. 16 and 17; Plate LII)

Sceloporus lineolateralis Smith, 1936, pp. 92-95.

Type locality. Six miles northeast of Pedriceña, Durango, Mexico. Holotype EHT & HMS 4323; paratypes EHT & HMS 4321-2, 4324-6, 4332-40, 4342-3, 4363, 4372a and b, 4471-6.

Diagnosis. A species of moderate size belonging to the *torquatus* group; dorsal head scales smooth; lateral scales about half as large as median dorsals, but not strongly differentiated from them; ventral scales about one third as large as laterals; longitudinal rows of dorsals converging toward median line; thirty-eight to forty-seven scales from occiput to base of tail; length of tibia about equal to length of shielded part of head; length of fourth toe about equal to distance between snout and posterior margin of ear; hind limb reaches to ear; fourteen to twenty femoral pores, not extending onto preanal region; enlarged supraoculars in a single row; two canthals; a narrow, uninterrupted black collar on neck, arising from shoulder, with a light, sometimes medially interrupted, posterior border; sides of belly in males china blue, very slightly darker medially; gular region very pale blue.

Description of type. Dorsal head scales smooth; a single row of enlarged supraoculars, bordered medially by a single row of small scales, and separated from the superciliaries by one complete and another incomplete row of scales; seven superciliaries, the last overlapping the preceding two (the sixth superciliary is entirely overlapped by the fifth); one large, heavily keeled subocular, followed posteriorly by a series of seven scales which curves upward about the orbit, contacting the parietal; lower two postocular scales strongly keeled; the series of scales between supraoculars and frontals continued downward between postoculars and margin of orbit, terminating at the second postocular (from subocular); preocular scale strongly keeled, in contact with second canthal and with the rows of scales above supralabials; loreal larger than subnasal, smaller than preocular, in contact with both canthals; two rows of low, elongate scales above supralabials, the lower row continuing around snout, passing above rostral, the other terminating anteriorly below the subnasal; two canthals, the second with but a very small por-

tion entering the superciliary series; rostral low, about three times as broad as high; interparietal at least twice as large as parietal, separated from frontal by a pair of frontoparietals in contact medially; a single large parietal on each side; frontal divided transversely, the anterior section about one half larger than posterior; two prefrontals, broadly in contact on median line, larger than anterior section of frontal; three frontonasals, the median about as large as either prefrontal; the lateral frontonasals somewhat smaller, in contact with both loreals; three irregular pairs of internasals, the pos-

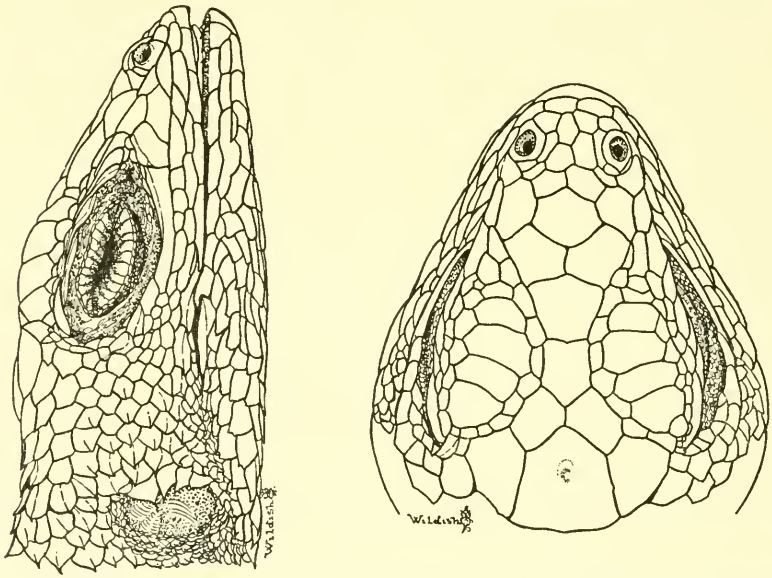

FIG. 16. Head scales of *Sceloporus lineolateralis* Smith. EHT & HMS 4323, six miles northeast of Pedriceña, Durango; actual head length, snout to occiput, 15 mm.

terior pair the largest and in contact with the frontonasals, the anterior pair smallest and in contact with the row of scales behind rostral; a single small scale separates the posterior internasals from anterior loreal, but does not enter series about nasal; latter broadly in contact with subnasal, narrowly in contact with row of scales above rostral, and surrounded above by four small scales; four supra- and five infralabials to a point below the middle of the eye.

Mental pentagonal, its labial border about two thirds that of rostral; mental followed by a series of four or five enlarged scales on each side, the anterior in contact with its fellow on the median ventral line; this series of scales separated from infralabials anteriorly by a single row of elongate scales (except anterior, which

is narrowly in contact with anterior infralabial), posteriorly by two rows, beginning below the middle of the third infralabial; scales on dorsal and lateral surfaces of head (including temporal region) more or less pitted; scales in temporal region keeled, mucronate in area near ear; four or five rows of scales on neck behind occiput nearly smooth, not or but weakly mucronate; anterior margin of ear with four smooth, pointed scales, the upper largest and larger than preceding scales; lateral neck fold low, relatively shallow, a weak fold from its upper margin to lower margin of ear; the scales surmounting this fold no larger than those adjacent, much smaller than those in the lateral gular region; median anterior gulars smaller than posterior median gulars; lateral gulars in region of angle of jaws much larger than median gulars; scale rows on neck parallel, abruptly differentiated from the scale rows arising near the insertion of the foreleg and passing obliquely upward onto back; median dorsals weakly keeled, mucronate, usually with not over one lateral mucrone, except on neck, where there may be as many as two; median dorsals about twice as large as laterals, gradually differentiated from them; laterals three or four times as large as median ventrals midway between fore and hind limbs; laterals more strongly keeled and mucronate than dorsals, with as many as three lateral mucrones; scales in axilla very small, smooth, rounded; scales following axilla gradually increasing in size and becoming more strongly mucronate, but smooth for about one third the distance from axilla to groin.

Dorsal scales of upper and lower foreleg keeled and mucronate, the latter somewhat smaller than dorsals on upper foreleg; dorsal scales on hand and toes smooth or very weakly keeled, the former slightly mucronate, some of the latter bi- or tricuspid; one dorsal, two lateral and one ventral row of scales around fingers and toes, all continuous to tip except the two laterals, which terminate behind the last scale of the other series; ventral scales of upper and lower foreleg smooth, the latter about twice as large as former; scales of palm and sole weakly keeled and mucronate; ventral lamellae with three or five mucrones, about equal in size; lamellar formula for fingers, 9-13-16-16-14 (9-13-16-15-14).

Dorsals of tibia and femur strongly keeled, mucronate, about the size of median laterals; anterior ventrals of femur and ventrals on tibia subequal in size; ventrals on femur decreasing in size toward femoral pores; lamellar formula for toes 7-12-19-21-18 (8-12-18-?-17); breast scales much larger than median ventral abdominal scales; median ventrals increasing in size laterally, merging with

laterals; anterior preanal scales about equal in size to those anterior to series of femoral pores; a pair of enlarged postanals; dorsal scale rows converging on base of tail; scales behind femoral pores, except one or two rows immediately adjacent to femoral pores, keeled, with three mucrones, of about the same size as those preceding the pore series; dorsal scale rows of tail somewhat larger than median dorsals on body, more strongly keeled and mucronate.

Color. Back, dorsal surface of limbs, and temporal region of head glaucous to pale blue; sides of body tinged with gray; a narrow black collar two or three scale rows wide on neck, arising almost straight from shoulders and not continued onto ventral surfaces; anterior and posterior borders of collar parallel, the latter with a light edge one or two scales wide; a few indistinct light spots on neck; sides of belly from axilla to groin china blue, lighter toward axilla, darker posteriorly; a small black area in groin, median edges of lateral blue areas very slightly darker, with no less than five rows of cream-colored scales separating them; gular region and breast very pale blue, the breast suffused with gray; ventral surfaces of limbs and tail cream.

Variation. Enlarged supraoculars invariably a single series; in three specimens two incomplete, as well as one complete, rows of small scales between supraoculars and superciliaries, latter usually six in number; the row of postoculars from the posterior border of the subocular to the temporal is irregular, but always two rather strongly keeled scales follow the subocular; the series of scales intercalated between the supraoculars and frontal is continued around the posterior border of the orbit in all specimens; the loreal contacts both canthals in all but one specimen (one side only); the preocular invariably touches the second canthal, but in ten specimens the lower portion is broken off to form an extra scute separating the remainder of the preocular from the rows of scales above supralabials; these latter rows of scales irregular, sometimes but a single scale separating medially the subocular from the supralabials; in all but one specimen one of the rows (apparently the upper one as a rule) is continuous around the snout above the rostral; in this exception the median scale above the rostral is apparently fused with the latter, the anterior pair of internasals thus contacting the rostral; twenty-one specimens have the frontoparietals separated, the frontal and interparietal in contact; the prefrontals and frontonasals are as in the type in all specimens; the internasals and scales about the nasals, however, are too irregular for description of variation.

although very frequently (perhaps normally) they are as in the type; character of scales on body and limbs uniform throughout.

The coloration of the males is practically identical with that of the type. A light line, barely visible in the type, passes from the upper labials directly through the ear to the black nuchal collar, passing above the lateral cervical fold; this line is more distinct in the young males, and is bordered above by a narrow black line arising on the posterior margin of the orbit and passing through the extreme upper edge of the ear and thence to the black collar. This line is variable and is most distinct in the young. In ventral coloration there is but little variation. The smallest male (44 mm. snout to vent) has very distinct lateral abdominal areas of blue, but the gular region and breast are white. In a male 54 mm. from snout to vent the gular region is as in the type, but with small scattered white flecks. The breast and median abdominal regions become grayish with increased size.

The females are markedly different from the males in coloration of the back. A light (whitish) line passes from above the insertion of the foreleg along the side of the body to the groin; above this is an irregular black line formed by the fusion of large black spots, which project upward from the black line; the latter arises from the upper margin of the insertion of the foreleg, separated from the black neck collar by the light posterior border of the latter; below the lateral light line is a narrow, indistinct and incomplete black line; on each side of the back is a row of large black spots, about six on each side; the ventral surface of the body, with the exception of the region anterior to the gular fold, is grayish.

Of the other described species of the *torquatus* group, only *j. jarrovii, torquatus, melanogaster, bulleri, serrifer* and *lineolateralis* have the supraoculars large, in a single row. *S. guentheri* may be distinguished by having a much longer fourth toe. *S. serrifer, torquatus* and *melanogaster* have much larger dorsal scales, with the lateral dorsals larger than the median dorsals. *S. j. jarrovii* differs not only in having the dorsal scale rows parallel, but in having the lateral scales larger, much shorter hind legs, different coloration, etc. *S. bulleri* has shorter hind legs, larger scales on the body, a broad neck band and much different ventral coloration.

It is of interest that in at least five of these species (*j. jarrovii, torquatus, melanogaster, serrifer,* and *lineolateralis*) the normal or very frequently occurring condition is for the frontal to contact the interparietal. This condition may occur in *guentheri* (not stated in de-

scriptions), but in most of the forms with two rows of supraoculars it occurs rarely (frequently in *dugesii*).

In body proportions, the narrow nuchal collar, the shape of the tail, and in various relationships of the head scales, *lineolateralis* suggests *formosus*. The nine species of this group (*formosus* Wieg-

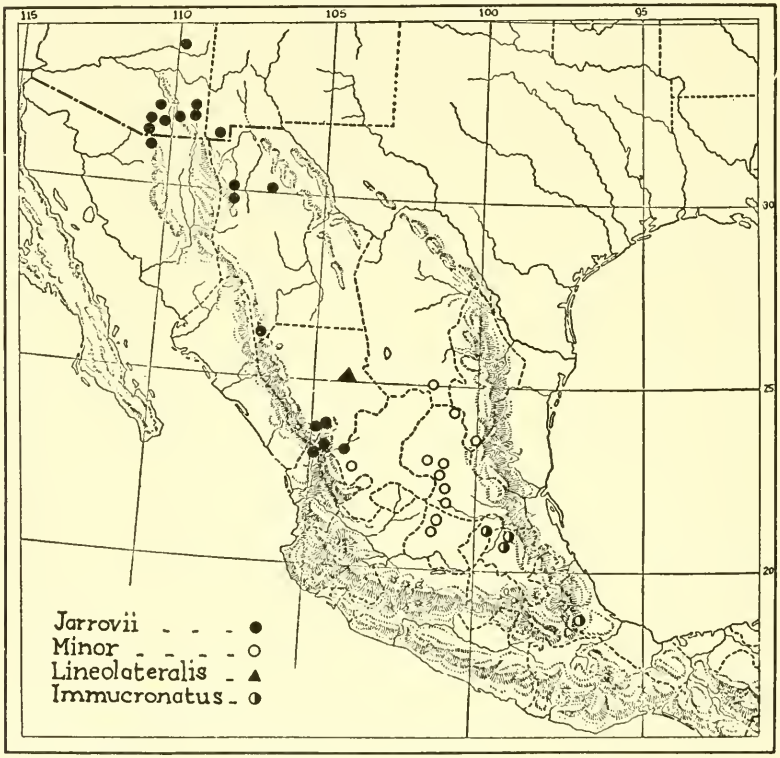

FIG. 17. Distribution of *Sceloporus lineolateralis* Smith, *S. jarrovii jarrovii* Cope, *S. jarrovii minor* (Cope) and *S. jarrovii immucronatus* Smith.

mann, *irazuensis* Günther, *lunaei* Bocourt, *malachiticus* Cope, *salvini* Günther, *schmidti* Jones, *smaragdinus* Bocourt, *taeniocnemis* Cope and *viviparus* Cope) which have been described, are not, however, comparable by description to the species here described, nor has direct comparison with many specimens of the *formosus* group from many localities in Central America and Mexico shown any close relationship to these species with *lineolateralis*.

Remarks. In some respects *lineolateralis* resembles *jarrovii*, a species which is closely associated geographically. It is possible

Measurements and Scale Counts of *Sceloporus lineolateralis* Smith

Museum	MCZ	EHT & HMS	MCZ	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	MCZ	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS
Number	6807	4363	6807	4323	4332	4338	4325	4339	6807	4333	4321	4322	4473	4474	4337	4340	4326	4324
Snout to vent	103.0	73.0	72.0	72.0	71.0	69.5	69.5	67.0	65.0	65.0	63.5	63.5	.....	58.5	55.0	53.0	51.0	49.0
Tail	.....	.....	102.0	.....	.....	.....	reg.	reg.	.....	111.0	reg.	.....	111.5	.....	.....	.....	.....	86.0
Snout to occiput	19.0	14.0	14.5	15.0	14.7	14.0	14.5	14.5	13.3	13.5	13.5	13.0	13.0	12.0	11.5	11.0	12.0	11.5
Snout to ear	24.0	17.5	17.5	19.5	19.0	18.0	19.0	18.5	15.5	15.5	17.0	16.5	16.5	15.0	14.0	13.5	14.5	13.8
Hind leg	62.3	48.5	45.0	51.0	49.5	48.0	50.0	48.5	42.0	46.0	46.0	44.9	48.5	42.0	40.0	45.0	39.5	36.0
Tibia	18.5	13.5	13.0	15.0	14.0	14.0	15.5	13.5	11.5	14.5	13.5	12.0	14.0	12.0	12.0	11.0	12.7	10.5
Fourth toe	22.0	17.0	16.4	19.0	18.5	17.0	19.5	18.5	15.9	17.5	16.5	16.7	18.0	16.5	15.5	14.5	15.9	13.0
Fifth toe	12.1	9.0	9.2	11.0	10.0	9.2	10.5	9.5	8.2	9.1	9.0	9.2	9.0	9.1	8.7	7.5	8.5	7.3
Lamellae, fourth toe	21–22	19.0	20–21	21.0	20.0	20.0	20.0	21.0	19–20	19.0	19.0	19.0	20.0	21.0	21.0	19.0	19.0	21.0
Femoral pores	16–17	17–18	16–18	19–19	19–19	16–16	18–19	18–19	17–17	20–?	14–15	17–17	20–20	17–18	19–20	18–?	18–18	19–?
Dorsals	46.0	41.0	47.0	40.0	38.0	43.0	41.0	38.0	43.0	43.0	40.0	42.0	45.0	40.0	44.0	43.0	41.0	45.0
Ventrals	68.0	61.0	63.0	65.0	60.0	61.0	67.0	65.0	61.0	62.0	60.0	59.0	58.0	62.0	65.0	62.0	58.0	64.0
Scales around body	52.0	46.0	51.0	52.0	49.0	47.0	49.0	56.0	50.0	53.0	46.0	53.0	52.0	50.0	49.0	48.0	53.0	54.0
Scales to head length	9.7	8.0	10.3	9.0	8.0	8.0	9.0	8.5	9.0	9.0	8.0	9.0	9.0	8.0	10.0	8.5	10.0	11.5
Ratio hind leg to snout-vent	60.4	66.4	62.5	70.8	69.7	69.0	71.9	72.3	64.6	70.7	73.4	70.7	.....	71.7	72.7	84.9	77.4	69.6
Ratio fourth toe to snout-vent	21.3	23.2	22.7	26.3	26.0	24.1	28.0	27.6	24.4	26.9	24.4	26.2	.....	28.2	28.1	27.3	31.1	28.5
Sex	♂	♀	♂	♂	♂	♀	♂	♀	♀	♀	♀	♀	♀	♀	♂	♀	♂	♂

that Boulenger's (1897) and Günther's (1890) specimens from Ciudad, Durango, are actually of *lineolateralis* and not of *jarrovii*.

Range. Known only from Durango.

Locality records. Six miles northeast of Pedriceña, Durango (EHT & HMS 4321-6, 4332-4340, 4342-3, 4363, 4372a and b; fourteen miles northeast of Pedriceña, Durango (EHT & HMS 4471-6); Guadelupe, Mexico (MCZ 6807 [3 spec.], Comisión geográfico exploradora).

Sceloporus jarrovii jarrovii Cope

(Text Figs. 17 and 18; Plate XLVII, Fig. 1)

Sceloporus jarrovii Cope, 1875, p. 48; *idem*, 1875, pp. 569-571, pl. 23, 2-2d; Yarrow, 1883, p. 57; Garman, 1884, p. 17; Cope, 1885, pp. 396, 403; *idem*, 1887, p. 38; Van Denburgh, 1896, p. 342; Cope, 1900, pp. 335, 341, 345-347, fig. 49; Stejneger, 1902, p. 150; Stone, 1911, p. 227; Bailey, 1913, p. 34; Van Denburgh and Slevin, 1913, pp. 392, 403; Stejneger and Barbour, 1917, p. 54; Van Denburgh, 1922, pp. 321-326, pl. 26; Stejneger and Barbour, 1923, p. 56; Van Denburgh, 1924, p. 207; King, 1932, p. 177; MacCoy, 1932, pp. 19-21; Stejneger and Barbour, 1933, p. 62.

Sceloporus yarrowi Coues, 1875, p. 595-6, pl. 23, figs. 2-2c.

Sceloporus yarrovii Boulenger, 1885, pp. 223-224; Günther, 1890, pp. XIII, 69; Boulenger, 1897, pp. 483-485 (part); Ditmars, 1907, pp. 129, 135.

Sceloporus torquatus poinsettii Cope, 1900, pp. 350-352 (part).

Type locality. Southern Arizona. Cotypes USNM 8494 (2 spec.) and 8495.

Diagnosis. A *Sceloporus* of the *torquatus* group; dorsal scales, 38 to 46 from occiput to base of tail; dorsal scales denticulate, weakly carinate; largest lateral scales somewhat larger than median dorsals; ratio of hind leg to snout-vent measurement, 54.1 to 65.8; ratio of fourth toe to snout-vent measurement, 18.8 to 25.4; enlarged supraoculars in a single series, bordered laterally by three rows of scales, two or three of which are incomplete; the inner of these three rows is composed of the largest scales; frontal usually in contact with interparietal, or separated by an azygous scale; prefrontals usually in contact; first canthal seldom forced above canthal ridge by contact of second canthal and subnasal; preocular usually not divided; usually two complete rows of scales below subocular. Black nuchal collar three or four scales wide, with a narrow light border sometimes not well defined; a suffusion of black confluent with the collar may occur over the neck and back; a light line two scales broad passes from the nuchal collar to the temporal region; scales on rest of dorsal surface black, with a light spot in the center of each scale.

Description (from K. U. 13145, male). Head scales smooth, strongly pitted in prefrontal and internasal regions; head not strongly depressed; interparietal large, fully four times the size of either parietal; parietal single on each side, subtriangular; fron-

toparietals single on each side, separated medially by contact of frontal and interparietal; posterior section of frontal about one third smaller than anterior section; prefrontals in contact medially; median frontonasal one third larger than either lateral frontonasal; nostril pierced slightly posterior to middle of nasal scale; anterior part of nasal much narrower than part surrounding naris; nasal and internasals separated from rostral by a row of small scales; scales in internasal region quite irregular; five-six enlarged supraoculars, separated from median head scales by a row of small scales; supraoculars separated from superciliaries by three rows of small

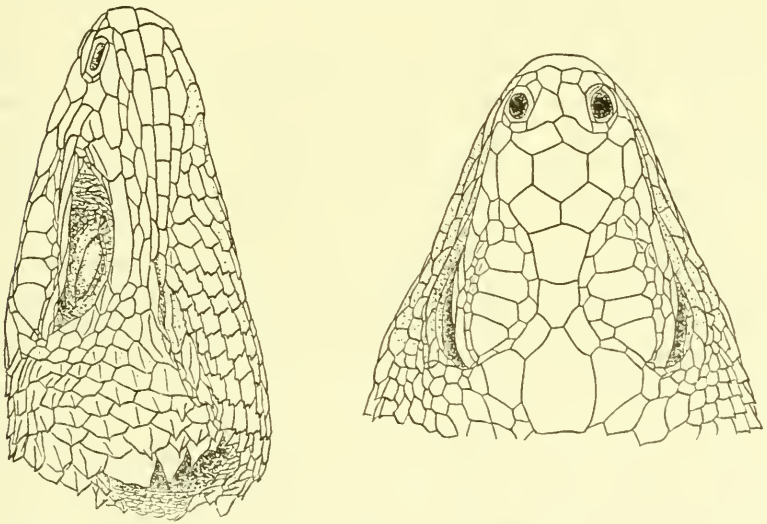

FIG. 18. Head scales of *Sceloporus jarrovii jarrovii* Cope. KU 12371, Montezuma Canyon, Huachuca Mts., Arizona; actual head length, snout to occiput, 17.5 mm.

scales, one complete and two incomplete; two canthals, the anterior smaller than the posterior; second canthal contacting subnasal on one side; subnasal somewhat larger than loreal; preocular not divided; subocular followed posteriorly by two small, strongly keeled, well-differentiated postoculars; two rows of lorilabials on sides of head, not reduced to one row at any point below subocular; four supralabials and five infralabials to a point below middle of eye.

Mental with a labial border about two thirds that of rostral; mental pentagonal, followed by a series of postmentals, only the anterior two or three of which are well differentiated; scales of anterior pair of postmentals in contact; outer row of labiomentals separated from mental by narrow contact of first infralabial and

first postmental; inner row of labiomentals terminating anteriorly at a point below posterior part of second infralabial; gular scales smooth, gradually increasing in size posteriorly; anterior gular scales rounded, not strongly imbricate; posterior gular scales strongly imbricating, with a single apical notch.

Three or four well-differentiated auricular lobules, the upper largest, rounded, the others pointed; scales in temporal region weakly keeled, weakly mucronate (more strongly mucronate near ear), somewhat smaller than largest scales between ear and lateral nuchal fold; scales in latter area keeled and very strongly mucronate; lateral nuchal fold relatively shallow; dorsal scales weakly keeled, weakly mucronate, those on neck and between shoulders without a well-differentiated apical mucrone; dorsal scales denticulate, their posterior edges with a somewhat truncate instead of rounded contour; lateral scales of body more strongly keeled, more strongly mucronate, more denticulate and not truncate; ventral scales slightly more than half the size of median dorsal scales, those on breast equal to or slightly smaller than those in middle of abdomen; preanal scales slightly more than half the size of scales in middle of abdomen; subcaudals smooth at base of tail; postanals enlarged, separated by four small scales; dorsal scales between hind legs somewhat smaller than preceding scales, one third or one fourth as large as scales on base of tail.

Dorsal scales of foreleg mucronate and weakly keeled, those on upper foreleg somewhat larger than those on lower foreleg and slightly smaller than median dorsals; ventral scales of lower foreleg subequal in size to dorsals of same member, smooth, mucronate; ventral scales of upper foreleg smaller than those of lower foreleg, smooth, notched; lamellar formula for fingers 9-13-15-15-12 (8-13-15-15-11).

Dorsal scales of hind leg keeled and mucronate, those on shank as large as or slightly larger than median dorsals on body, and distinctly larger than those on thigh; ventral scales of shank somewhat smaller than dorsals of same member, smooth, mucronate; ventral scales of thigh subequal in size to preanal scales, smooth, notched; scales on posterior surface of thigh somewhat larger than preanal scales, keeled, weakly mucronate, abruptly decreasing in size immediately posterior to femoral pore series; no postfemoral dermal pocket; lamellar formula for toes 8-12-16-19-14 (8-12-17-18-14).

Color. General dorsal ground color black; head reddish-brown, with a light yellow-brown spot on nearly every scale; black nuchal collar three or four scales broad, with a broad median extension

about six scales wide from its anterior border to occiput; lateral to this black band a pale-blue line two scales wide, passing from anterior edge of black collar to posterior corner of eye; lateral to this, an indistinct dark band confluent with black collar posteriorly, passing to eye anteriorly; this is followed laterally by pale blue, which color continues on sides of head and neck; black nuchal collar continuous around throat; no distinct light posterior border for collar; each scale on back and sides with a large median pale-blue spot; limbs with narrow, indistinct dark bands; tail dimly banded.

Ventral surface of head pale blue, somewhat darker than sides of head; middle of abdomen cyanine blue, the color extending onto preanal region and ventral surface of femur, becoming somewhat lighter; no light median abdominal band, the blue color of the sides fusing medially and leaving isolated median areas lighter in color; a black patch in groin; a small area in immediate area about anus cream-colored; ventral surface of tail pale blue, with an indefinite suffusion of cream medially.

Variation. The variation in head scales of thirty-six specimens is as follows: The frontal contacts the interparietal in sixteen, and is separated by an azygous scale in eleven, by contact of the two frontoparietals in eight (one specimen injured); the anterior frontal is longitudinally divided in one; the median frontonasal contacts the frontal in five, is separated by an azygous scale in two, and by contact of the prefrontals in twenty-nine; the second canthal touches the subnasal on both sides in six, on one side in seven; the first canthal is always present; the supraoculars are always in a single series, always with a few small scales segmented off the series of enlarged scales, but not approaching the size of the latter; scales between supraoculars and superciliaries in three incomplete rows; row of scales bounding supraoculars medially always complete, the length of each scale about equal to its width; preocular scale separated from the two rows of scales above supralabials in ten (one side only in two); subocular separated from supralabials by two complete rows of scales, occasionally (in nine) reduced to one by one scale; posterior fourth of subocular segmented off on both sides in two, on one side in two; outer row of labiomentals touching mental in two, separated by a partial contact of first infralabial and first postmental in remainder; inner row of labiomentals extends anteriorly to a point even with the suture between the second and third infralabials, never extending farther than the middle of the second infralabial,

not beginning farther back than the middle of the third infralabial. The second pair of postmentals contacts medially in one specimen.

The femoral pores vary between thirteen (one specimen, one side) and eighteen, and the dorsal scales from occiput to base of tail are usually forty to forty-six; three specimens from Moctezuma, Chihuahua, have a higher average (47, 48, 52).

Specimens from various localities in the mountains of western Chihuahua have a peculiar variation in color pattern which I have not observed in specimens from other localities. The back and neck are strongly suffused with black, which is continuous with the black nuchal collar. This in turn has lost its light borders medially. Apparently no other differences accompany this color variation. Certain specimens from the same localities have a normal color pattern similar to that found in Arizona specimens. As a general rule the pattern so characteristic of Arizona material, of a light spot on each scale on the back, is usually not evident on Mexican specimens. Stejneger (1902, p. 150), however, remarks that under certain environmental conditions the spotted pattern is not evident even in Arizona specimens.

Habits and habitat. Ecologically, *jarrovii jarrovii* seems to be confined for the most part to areas of high elevation. The three specimens collected near Moctezuma, Chihuahua, are the only ones, so far as I am aware, which have been found at a low elevation. These were found in a semiarid region, on low, barren hills capped by large, granite boulders. They were in company with *S. poinsettii.*

Range. From central Arizona east to western New Mexico, and south through Chihuahua and western Sonora to extreme western Zacatecas and extreme northern Tepic. (See fig. 17 for distributional map.)

Locality records. ARIZONA: *Cochise Co.:* (Yarrow, 1883, Van Denburgh, 1896, 1922; Boulenger, 1897; Cope, 1900; Stejneger, 1902; Stone, 1911; Van Denburgh and Slevin, 1913; K. U. 6885-6919, 7018-7039, 7091-7093, 7311-7336, 7521-7533, 10836, 11840-11872, 12349-12429, 12431-12441). *Pima Co.:* (Van Denburgh, 1922; King, 1932). *Santa Cruz Co.:* (Cope, 1900; Van Denburgh, 1922; MacCoy, 1932; K. U. 13143-13156). *Navajo Co.(?):* (Yarrow, 1883; Cope, 1900). NEW MEXICO: (Bailey, 1913); *Hidalgo Co.:* Animas Peak and Big Hatchet Mts. (Van Denburgh, 1924). SONORA: Pinetos Camp, thirty-two miles south of Nogales (Van Denburgh, 1922). CHIHUAHUA: Ten miles south of Moctezuma (DHD & HMS 98-100); Samachique (FMNH 15723 [6 spec.], 11829-39, Robert M. Zingg); Colonia Garcia (FMNH 1658, C. M. Barber;

USMN 46660-1, Nelson & Goldman; MCZ 7476, C. S. Brimley); Sierra Madre (USNM 47422, 47234-8, Nelson & Goldman); San Luis Mts. (USNM 47015, E. A. Goldman; USNM 21032, E. A. Mearns; Guadelupe (USNM 47066, Nelson and Goldman); Meadow Valley (USNM 26600, Brimley); Madera (MCZ 17526-7, W. W. Brown, 4,400 ft.); Pacheco (MCZ 15610-4, W. W. Brown). DURANGO: Huasamota (USNM 46930, Nelson & Goldman); El Salto (USNM 46638 Nelson & Goldman); Coyotes (FMNH 1511 [19 spec.], Heller & Barber); Cuidad (Boulenger, 1885, 1897; Cope, 1887; Günther, 1890). ZACATECAS: Sierra Madre (USNM 46934, Nelson & Goldman). TEPIC: Santa Teresa (USNM 46630, Nelson & Goldman).

Remarks. A specimen reputed to be from Monclova (probably meant for Coahuila) (MCZ 4557), collected by Palmer in 1880, appears to have incorrect locality data. It was in a jar with a specimen presumably from the same locality, but which possesses a tag stating "San Luis Potosi," and which is typical *jarrovii minor.* The untagged specimen is well preserved and not faded, while the other is shrunken and faded. Until further collecting indicates the presence of *jarrovii* in this region of Coahuila, I assume the locality data to be incorrect.

Six specimens are present in Field Museum (384), collected by E. S. Walton in August, 1897, at Fort Bliss, Arizona (Texas?).

The validity of the report of *jarrovii* from "North of Rio Santiago, Jalisco," cannot be definitely accepted because of the confusion by Boulenger of *dugesii dugesii* and *jarrovii,* and because of the possibility of erroneous locality data. The table of characters given by Boulenger (p. 484) indicates that the specimen *not forming* the type of *pleurolepis* may be *jarrovii,* but the *pleurolepis* type, from the same locality, almost certainly is *dugesii dugesii.* Boulenger has other specimens from Duvall Co., Texas (locality incorrect, or the specimen is *poinsettii*), Catorce, San Luis Potosí (probably *jarrovii minor*), and from La Cumbre de los Arrastrados, Jalisco, Ixtlán, Jalisco, and La Venta, Guadalajara, all of which specimens are very probably *d. dugesii.*

S. jarrovii seems to be most closely related to *d. dugesii.* However, the two forms are sufficiently different that it seems unwise to place them as subspecies until intergradation is definitely established as a fact.

Some of the differences which may be pointed out are: supraoculars entire in *jarrovii,* partly divided in *dugesii;* prefrontals usu-

Measurements and Scale Counts of *Sceloporus jarrovii jarrovii* Cope

Museum	USNM	USNM	DHD & HMS	USNM	DHD & HMS	DHD & HMS	FMNH	USNM	USNM	USNM
Number	47015	46930	99	46934	100	98	1511	47236	46661	47422
Snout to vent	65.0	70.0	72.0	74.0	74.5	77.0	85.0	86.0	88.0	89.0
Tail	74.0	.....	.....	.....	.....	.....	113.0	.....	.....	.....
Snout to occiput	13.0	14.7	13.0	14.5	13.5	13.5	18.2	17.5	16.0	16.0
Snout to ear	15.8	16.8	17.0	17.5	17.5	17.5	21.9	21.2	21.7	20.0
Hind leg	42.8	44.2	43.5	47.5	42.0	46.0	53.0	52.0	52.8	48.2
Tibia	12.0	14.5	13.0	15.0	14.0	13.5	15.0	16.0	15.8	16.8
Fourth toe	15.2	16.5	16.2	18.6	16.5	16.0	19.8	19.8	19.0	16.8
Fifth toe	8.5	8.8	9.0	10.3	9.2	9.0	11.2	11.3	9.6	10.0
Lamellae, fourth toe	18–19	20–19	17–18	20–20	19–19	18–19	20–20	20–21	19–?	18–19
Femoral pores	15–15	14–16	17–17	15–16	14–15	14–15	17–17	15–16	16–17	14–16
Dorsals	46	43	47	44	52	48	42	38	45	44
Ventrals	61	61	59	68	61	60	65	51	60	59
Scales around body	44	53	48	49	53	50	49	45	42	49
Scales to head length	8.0	9.3	8.0	8.0	10.0	8.0	9.0	7.2	8.7	8.6
Ratio, hind leg to snout-vent	65.8	63.1	60.4	64.1	56.3	59.7	62.3	60.4	60.0	54.1
Ratio, fourth toe to snout-vent	23.3	23.5	22.5	25.1	22.1	20.7	23.2	23.0	21.5	18.8
Sex	♀	♀	♀	♀	♀	♀	♂	♂	♂	♀

ally in contact in *jarrovii,* usually separated in *dugesii;* rows of scales between subocular and supralabials usually reduced to one at some point in *dugesii,* usually two complete rows in *jarrovii;* dorsal head scales smooth (although pitted) in *jarrovii,* rugose (microscopically) in *dugesii;* dorsal scales from occiput to base of tail usually more numerous in *dugesii* (41-50) than in *jarrovii* (40-46 recorded by Van Denburgh [1922], average 43; the three specimens of *jarrovii* from Chihuahua are exceptional and have 48, 47 and 52); femoral pores fewer in *dugesii* (9-13); posterior frontal not reduced in *jarrovii* as in *dugesii.* The light spot in the center of each scale is missing in *dugesii.*

Sceloporus jarrovii minor (Cope)

(Text Figs. 17 and 19; Plate LIII, Fig. 2)

Tropidolepis poinsettii ? Dugès, 1870, p. 243.

Sceloporus torquatus minor Cope, 1885, p. 402; *idem,* 1887, p. 38; *idem,* 1900, pp. 353, 349.

Sceloporus poinsettii ? Dugès, 1887, p. 114; Garman, 1887, p. 14.

Sceloporus yarrovii Boulenger, 1897, pp. 483-485 (part).

Type locality. Zacatecas. Cotypes USNM 26166-7; Dugès, collector.

Diagnosis. A species of moderate size belonging to the *torquatus* group; dorsal head scales smooth; largest lateral scales subequal in size to, or somewhat larger than, dorsals, ventrals much smaller than (about one fourth as large as) dorsals; femoral pore series short, not extending onto preanal region, sometimes with an extra short series; dorsals 34 to 46 from occiput to base of tail; dorsal scales smooth or very weakly keeled, very weakly mucronate, in parallel or very slightly converging rows; tibia as long as or longer than shielded part of head; fourth toe from base of fifth equal to or greater than distance from snout to ear; supraoculars usually in two complete rows, never in one row; black collar continuous around gular region, on dorsal surface of neck very broad, covering from six to eight scale rows; collar with narrow light borders, sometimes interrupted; adults with a ground color of uniform seal brown, with distinct, narrow light bands on distal portion of tail, not encroaching upon ventral surface; males with sides of abdomen from axilla to groin pale blue, sometimes with a purple suffusion, the median edges and area in groin black or marine blue; throat pale blue, sometimes spotted.

Description (EHT & HMS 4207, San Felipe, Guanajuato). Dorsal head shields smooth; enlarged supraoculars in two rows, bordered medially by a single row of small scales, and separated from the

superciliaries by one complete and another incomplete row of scales; six superciliaries, the last overlapping the preceding two (the fifth superciliary is entirely overlapped by the fourth); one large, heavily keeled subocular, followed posteriorly by two elongate, heavily keeled postoculars; the series of scales between supraoculars and frontals continued downward, bordering posterior margin of orbit, and contacting the upper (posterior) postocular; preocular scale strongly keeled, in contact with second canthal and with the rows of

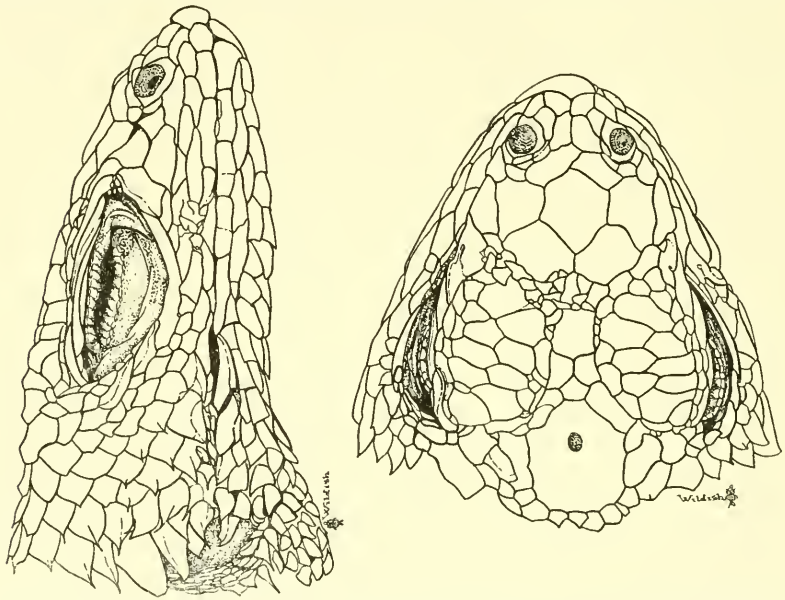

FIG. 19. Head scales of *Sceloporus jarrovii minor* (Cope). EHT & HMS 4207, near San Felipe, Guanajuato; actual head length, snout to occiput, 17.5 mm.

scales above supralabials; loreal very slightly larger than subnasal, somewhat smaller than preocular, in contact with both canthals; two irregular rows of scales above supralabials and in contact with subocular, preocular, loreal and subnasal, one row continuous around snout above rostral; two canthals, the second with but a very small portion entering the superciliary series; rostral low, at least three times as broad as high; interparietal much larger than either parietal, roughly pentagonal, the posterior edge straight, the sides nearly parallel; a single parietal on each side, but little larger than frontoparietal; a pair of frontoparietals, in contact on median line and separating frontal from interparietal; frontal transversely divided; two prefrontals, in contact on median line; three fronto-

nasals, the lateral in contact with both canthals; two pairs of internasals, the posterior pair somewhat larger than the anterior, the former separated from the first canthal by a small scale; six to seven scales, including the subnasal, surround the nasal; four supra- and five infralabials to a point below the middle of the eye.

Mental pentagonal, its labial border about two thirds that of rostral; mental followed by a series of five or six enlarged scales on each side, the anterior in contact with its fellow on the median ventral line; this series of scales separated from infralabials anteriorly by a single row of elongate scales (except anterior, which is narrowly in contact with anterior infralabial), posteriorly by two rows, the second row beginning below the middle of the third infralabial and in contact with the series of postmental scales; scales in temporal region keeled, mucronate in area near ear; anterior margin of ear with five smooth, pointed scales, the upper two larger than the preceding scales; lateral cervical pouch rather shallow; a fold of skin from about its middle to the lower margin of the ear, surmounted by enlarged, pointed scales; scales adjacent to this fold and gular scales in region of angle of jaws subequal in size; dorsal scales in parallel rows, the scales near the median line very weakly keeled or smooth, rounded or very weakly mucronate; scales on sides very weakly keeled, with one to five weak mucrones; scales between axilla and groin smooth, but with five or seven mucrones; largest dorsal scales on body about half as large as largest dorsal caudals; scales in anterior median part of region in front of gular fold smaller than scales near gular fold; the latter scales but slightly smaller than those near angle of jaw; scales on breast largest of ventrals on body; median abdominal scales somewhat smaller than lateral abdominals.

Dorsal scales of body somewhat larger than those on dorsal surface of upper foreleg, these somewhat larger than those on dorsal surface of lower foreleg; dorsal scales of foreleg weakly keeled and mucronate, those on hand nearly smooth; ventral scales of foreleg smooth, mucronate, those on lower foreleg as large as or larger than the dorsals of the same member, those on upper foreleg much smaller than those on lower foreleg; one dorsal, two lateral and one ventral row of scales around fingers and toes, all continuous to tip except the two laterals, which terminate behind the last scale of the other series; lamellar formula for fingers ?-13-18-17-12 (8-15-18-18-14). Dorsal scales of hind limb keeled, mucronate, those on tibia as large as largest dorsals on body, those on femur somewhat smaller; ventral scales of tibia and femur smooth, rounded, those on tibia

somewhat smaller than dorsal scales of same member; scales on anterior surface of femur smooth, large as dorsals of same member; ventral scales of femur, near femoral pores, about equal in size to preanals; scales on posterior surface of femur, immediately behind femoral pores, much smaller than preanals; scales in median area of posterior surface of femur about four times as large as those immediately behind pore series; lamellar formula for toes 10-14-18-20-14 (9-14-20-21-16); a pair of enlarged postanals; subcaudals smooth near proximal end of tail, becoming weakly keeled toward distal end; dorsal caudals more strongly keeled than scales on body, mucronate.

Color. Ground color above uniform olive to Prout's brown; no markings on back or limbs; neck traversed by an extremely broad, black band passing over the shoulder and dimly crossing gular fold region; the band covering seven or eight scales in the median dorsal line; collar light-bordered, the posterior border narrow (one scale wide), the anterior border broader (two or parts of two scales wide); a broad, light band about two scale rows wide between upper edge of ears, separated by a dim, bluish-gray band from the light anterior border of neckband; posterior border of neckband very strongly convex, the median part rather angular, the anterior border straight; head clove to seal brown; sides of belly from axilla to groin pale blue, with a narrow median border of black; a small area in groin black; breast, a median abdominal band about four to six scale rows wide, ventral surface of limbs, preanal region and ventral surfaces of tail whitish; region of gular fold gray; area in front of this gray intermingled with blue, and with small, scattered white flecks.

Variation. The following variation of fifty-four specimens was noted: The frontoparietals contact medially in ten; they are separated by an azygous scale in forty-one, and by contact of the frontal with the interparietal in three. The frontoparietals are divided into two on both sides in four, on one side in three. The anterior frontal is divided longitudinally in ten specimens. The posterior frontal is divided into four scales in one specimen, into three in six, and into two scales in three specimens. An azygous scale separates the prefrontals in three; they are separated by contact of the median frontonasal and the anterior frontal in five; in the remainder they contact medially. These primary head shields vary but little in comparison with *poinsettii;* fusion and irregular segmentation do not frequently occur, and never to the degree common in the latter form.

The supraoculars are almost always in two complete rows; in four or five specimens the outer row is short, composed of but two or

three scales. Usually there is not a great difference in the size of the scales in the two rows. There is no irregular segmentation of the scales as is the rule in *cyanogenys* and *immucronatus*. The first canthal is forced above the canthal ridge by contact of the second canthal and subnasal on both sides in six specimens. In two of these it appears that the first canthal may be gone entirely (perhaps fused), but in the others it is obvious that it has been merely pushed up to take a place in the series of small scales about the nostril. The first canthal touches the series of scales above the supralabials on both sides in five specimens, on one side in one. The preocular is separated from these rows of scales on both sides in eight specimens, on one side in ten. The two rows of scales between the subocular and supralabials are reduced to one row at some point on both sides in twenty-nine specimens, on one side in ten.

The medial row of the two rows of scales intercalated between the postmentals and infralabials extends anteriorly to the anterior half of the second labial in one count (two counts per specimen); to the middle of the second in six; to the posterior half of the second in ten; to the suture between the second and third in forty-eight; to the anterior half of the third in thirty-four; to the posterior part of the third in one; and to the suture between the third and fourth in two.

Much variation occurs in the arrangement of the scales between the frontonasals and rostral. There are never more than two pairs of internasals, although one or both pairs of internasals may be broken into two or more smaller scales, or fused together in part. The rows of scales above the rostral and anterior to the first pair of internasals is present in the entire series, with usually four in the series between the middle of the nares (two in one specimen, three in two, five in two and six in one).

The dorsal scale rows are distinctly converging in eleven specimens; in the others they are either parallel or weakly converging (weakly converging is used in description of cases in which a single scale row drops out somewhere on the back, and the other rows show some evidence of converging to accommodate this loss; in some a row may be dropped out, and the scales of the adjacent rows enlarged immediately posterior to this point, with the result that no convergence is apparent).

The basal caudal scutes are from one and one third to two or more times larger than the median dorsals.

The postanal scales are but slightly enlarged in some males; in the young males they are not visibly enlarged. In two male speci-

mens the femoral pore series is double near the median end, increasing the pore count from a maximum of 17 to a maximum of 23 (20-22 in one specimen, 21-23 in the other).

The males vary somewhat in ventral coloration. The throat, anterior to the gular fold region, is usually uniform pale blue. The sides of the belly are also pale blue in some specimens; in older males the black neckband is continued very distinctly across the gular fold region; in the largest the black borders of the lateral blue abdominal areas are expanded and meet on the median ventral line, and some black spotting is present on the preanal region. The light band between the upper margins of the ear are present in all adult males, but is either absent or broken into spots in young males and in females.

The dorsal coloration of the females is much like that of the males. The light band across the neck between the upper margins of the ear is either absent or indicated only by irregular light spots. In most of them the back is uniform, as in the males, but in some there are indistinct dark and light areas scattered over the back. The black spots tend to form in rows, and down each side of the middorsal line, and the light spots border posteriorly each dark spot. In most specimens in which these spots are visible, however, they are quite indistinct and irregular in their disposition. The young specimens are more frequently so spotted than the larger females.

The sides of the belly in the females are grayish; the area anterior to the gular fold region is also grayish, with irregular light spots, or light lines converging toward the middle. The ventral surfaces of the tail, limbs and the preanal region are cream to white.

The tail, which is broken in the type, is Vandyke or seal brown toward the distal end, and has fairly distinct, narrow bands of whitish, usually one scale wide. These bands do not encroach upon the ventral surface of the tail, although the darker color may be visible toward the tip.

Remarks. *S. j. minor* occupies the northern central plateau region of Mexico, and presumably intergrades with *immucronatus* to the east. All specimens are quite uniform in character except few specimens in a large series from Charcas, San Luis Potosí. In three specimens the dorsal scales from occiput to base of tail are 35-35-34. This represents an extreme, from one locality, much lower than that from any other locality. Thirty-six scales are present in two specimens from San Felipe, and all the remainder have no less than thirty-eight. Another specimen from farther north than Charcas (El

Salado) has characters typical of *minor*, including scale counts, form of supraoculars and general character of other head scales.

The characters which differentiate *minor* and *cyanogenys* may be summarized. In coloration the differences are striking. The black nuchal collar is much broader in *minor*, the light anterior borders are rarely divided (more frequently in the Charcas and El Salado specimens), and the general coloration more brownish and darker.

In scale characters, *minor* has a higher average number of scales from occiput to base of tail; the supraoculars are rarely not in two complete rows in *minor*, and rarely in two rows in *cyanogenys;* the preocular is usually not separated from the rows of scales above the supralabials in *minor*, usually separated in *cyanogenys;* and scales to head length (snout to occiput) fewer in *cyanogenys*.

Cyanogenys also reaches a much greater maximum snout-to-vent length than *minor* (143 mm. in the former, 100.5 in the latter).

Range. Northern parts of the states of Querétaro and Guanajuato, north through western Zacatecas, including most of San Luis Potosí, to southern Coahuila. (See Fig. 17 for distributional map.)

Locality records. Guanajuato: (Cope, 1887); near San Felipe (EHT & HMS 4198-4212, 4228, 4246, 4248-4262); three miles northeast of Santa Rosa (EHT & HMS 3756-3759); near El Terero (EHT & HMS 4276-4278). *Zacatecas:* (Cope. 1885, 1900; USNM 26166-7) (type locality); Valparaiso Mts. (USNM 47868-70, 47816-7, E. A. Goldman). *San Luis Potosí:* (USNM 4557, Palmer); near San Luis Potosí (MCZ 4548 [2 spec.], Dr. Edw. Palmer); Morales (MCZ 20020-5, W. W. Brown); Alvarez (MCZ 20062, 28265-28325 [+45 duplicates], W. W. Brown; UMMZ 67692 [25 spec.], W. W. Brown); Alvarez or Morales (MCZ 4 spec.); Concordia (MCZ 4569 [3 spec.], Dr. Edw. Palmer); Charcas (UMMZ 77275-77282 [71 spec.], C. L. Lundell); Jesus Maria (USNM 47297, 47299, E. W. Nelson); Villar (USNM 47300-1, 47161, E. W. Nelson); Ahualuko (USNM 47298, E. W. Nelson); Santa Inez Mine, Charcas (USNM 17656-9, P. L. Jouy; Cope, 1900); thirty miles north of El Salado (EHT & HMS 4170). *Coahuila:* Sierra Guadelupe (USNM 46700, 46702, 47493-5, Nelson & Goldman). *Nuevo León:* Miquihuana (USNM 46741-2, Nelson & Goldman).

Measurements and Scale Counts of *Sceloporus jarrovii minor* (Cope)

Museum	UMMZ	USNM	EHT & HMS	EHT & HMS	MCZ	EHT & HMS	USNM	USNM	EHT & HMS	USNM	UMMZ	EHT & HMS	UMMZ
Number	77275	47494	4206	3756	4569	3758	26166	47495	4209	47493	77275	4250	77275
Snout to vent	71.0	72.0	72.5	74.5	75.0	75.5	76.0	77.0	78.0	78.5	79.5	80.0	80.0
Tail	.....	.....	108.0	105.0	.....	105.0	.....	.....	.....	.....	.....	.....	.....
Snout to occiput	13.0	13.5	13.5	14.0	13.2	13.5	13.4	15.3	14.0	14.0	15.0	14.0	14.0
Snout to ear	16.0	18.5	17.5	17.0	16.7	17.3	17.5	18.1	18.5	18.3	19.0	18.0	17.0
Hind leg	45.0	46.0	49.0	47.5	45.2	48.0	47.7	52.2	49.5	52.5	51.0	49.0	47.2
Tibia	13.0	14.5	14.5	14.0	13.4	14.5	14.6	15.0	14.5	15.2	15.0	15.5	14.0
Fourth toe	15.7	16.3	19.0	19.0	16.3	19.0	16.1	19.8	18.0	18.9	17.7	18.0	16.5
Fifth toe	8.0	8.3	10.0	10.0	8.0	10.0	8.0	9.5	10.0	9.7	9.3	10.0	9.0
Lamellae, fourth toe	19–19	20–20	21–21	19–19	19–20	20–20	21–22	20–20	20–20	19–19	20–21	20–20	19–19
Femoral pores	11–12	15–?	11–11	11–12	13–14	12–12	14–14	14–16	12–14	14–15	11–12	14–14	11–11
Dorsals	37	41	36	39	38	39	40	40	40	42	38	43	35
Ventrals	55	54	55	59	51	59	51	54	59	58	61	59	51
Scales around body	40	43	42	48	40	42	42	43	47	40	41	48	40
Scales to head length	6.7	9.3	7.0	7.5	7.3	8.0	6.8	7.6	7.0	8.0	7.0	8.0	5.0
Ratio, hind leg to snout-vent	63.3	63.8	67.5	63.7	60.2	63.4	62.7	67.7	63.4	66.8	64.1	61.2	59.0
Ratio. fourth toe to snout-vent	22.1	22.6	26.2	25.5	20.7	25.1	21.1	25.7	23.0	24.0	22.2	22.5	20.6
Sex	♀	♂	♀	♀	♀	♀	♀	♂	♀	♂	♂	♀	♀

Measurements and Scale Counts of *Sceloporus jarrovii minor* (Cope)—Concluded

Museum	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	UMMZ	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	USNM	USNM	EHT & HMS
Number	3759	4277	4260	4246	77275	4262	4259	4205	4207	47867	47870	4261
Snout to vent	81.5	83.0	84.5	84.5	88.5	89.0	89.0	90.0	97.0	97.0	100.0	100.5
Tail	.....	125.0	127.0	121.0	.....	128.0	.....	.....	.....	138.0	.....	.....
Snout to occiput	15.0	15.0	15.3	14.5	16.0	14.5	16.0	16.5	17.5	18.7	18.3	16.0
Snout to ear	19.0	19.5	19.5	.....	21.0	19.0	20.5	21.0	23.0	23.5	22.5	21.0
Hind leg	54.5	55.0	54.5	52.0	54.5	55.0	60.0	59.5	62.5	.....	60.0	62.0
Tibia	15.0	17.0	15.0	14.8	16.0	16.0	17.5	18.5	18.5	.....	17.5	17.5
Fourth toe	22.0	20.0	20.0	19.0	19.0	19.0	22.0	22.9	22.5	22.7	21.0	22.0
Fifth toe	11.9	11.0	11.1	11.5	10.0	10.9	11.1	13.0	12.0	11.7	10.7	12.0
Lamellae, fourth toe	24–24	23–23	20–20	20–20	18–18	21–21	24–24	21–21	21–21	21–23	21–21	23–23
Femoral pores	12–13	20–22	12–12	21–23	9–10	11–13	12–14	11–12	11–12	15–16	15–16	15–15
Dorsals	43	46	45	42	35	41	46	41	39	40	44	44
Ventrals	67	62	56	61	50	56	61	60	56	62	60	60
Scales around body	50	47	44	48	38	41	49	48	45	52	54	46
Scales to head length	9.0	8.0	8.0	7.0	6.0	6.5	8.7	7.3	7.5	8.8	8.5	7.5
Ratio, hind leg to snout-vent	66.8	66.2	64.4	61.5	61.5	61.7	67.4	66.1	64.3	.....	60.0	61.3
Ratio, fourth toe to snout-vent	26.9	24.0	23.6	22.4	21.4	21.3	24.7	25.4	23.1	23.4	21.0	21.8
Sex	♂	♂	♂	♂	♂	♀	♂	♂	♂	♂	♂	♂

Sceloporus jarrovii immucronatus Smith

(Text Figs. 17 and 20; Plate LIII, Fig. 1)

Sceloporus torquatus poinsettii ? Boulenger, 1885, p. 220 (part); ? *idem*, 1897, p. 481 (part).

Sceloporus jarrovii immucronatus Smith, 1936a, pp. 223-227.

Type locality. Ten miles north of El Pinalito, Hidalgo, Mexico. Holotype EHT & HMS 500; paratypes EHT & HMS 498-9, 501-4, 506-8, 510-1, 605-615; E. H. Taylor and H. M. Smith, collectors.

Diagnosis. A species of moderate size belonging to the *torquatus* group; head shields smooth; laterals in diagonal rows, weakly keeled, very weakly mucronate; the median laterals somewhat larger than, to one and one half times as large as, median dorsals; dorsals in parallel longitudinal rows, very weakly keeled, but slightly mucronate, 37 to 46 from occiput to base of tail; supraoculars usually in two rows, the inner complete, the outer incomplete; canthals regularly two; tibia as long as or slightly longer than shielded part of head; fourth toe from base of fifth slightly longer than distance from snout to posterior margin of ear; ratio of fourth toe to snout-vent measurement, 23.8 to 28.6 (in adults); ratio of hind leg to snout-vent measurement, 64.0 to 71.3; femoral pores, 12-19; ground color, cobalt blue; collar black, complete, narrow (2 or 3 scales wide), extending across gular fold region in males; region anterior to gular fold and sides of belly cobalt blue; ventral surfaces of limbs and tail glaucous blue or pale blue; median ventral surface of belly in old males black, the color extending onto proximal portion of ventral surfaces of limbs.

Description of type. Dorsal head shields smooth; enlarged supraoculars in two rows, the outer row formed of scales about one half as large as those of inner row; supraoculars separated from superciliaries by one complete and another incomplete row of scales (the latter present on one side only), and bordered medially by a series of small scales; superciliaries six, the last overlapping the preceding two (the fifth superciliary is entirely overlapped by the fourth); one large, heavily keeled subocular, followed posteriorly by two small, strongly keeled postoculars, these in turn followed by a series of scales passing upward and contacting the parietal; the series of scales between the supraoculars and frontals continued downward between the former series of scales and the margin of the orbit, terminating at about the middle of the posterior postocular; preocular scale strongly keeled, in contact with second canthal and with the rows of scales above supralabials; first canthal in contact with rows of scales above supralabials, separating the loreal from the pre-

ocular; about three fifths of the length of the second canthal forming a part of the superciliary series; rostral about three times as broad as high; two irregular rows of scales above supralabials and in contact with subocular, preocular and subnasal, one row continuous around snout above rostral; interparietal much larger than either parietal, more triangular than pentagonal in shape; a pair of frontoparietals, separated on the median line by the contact of frontal and inter-

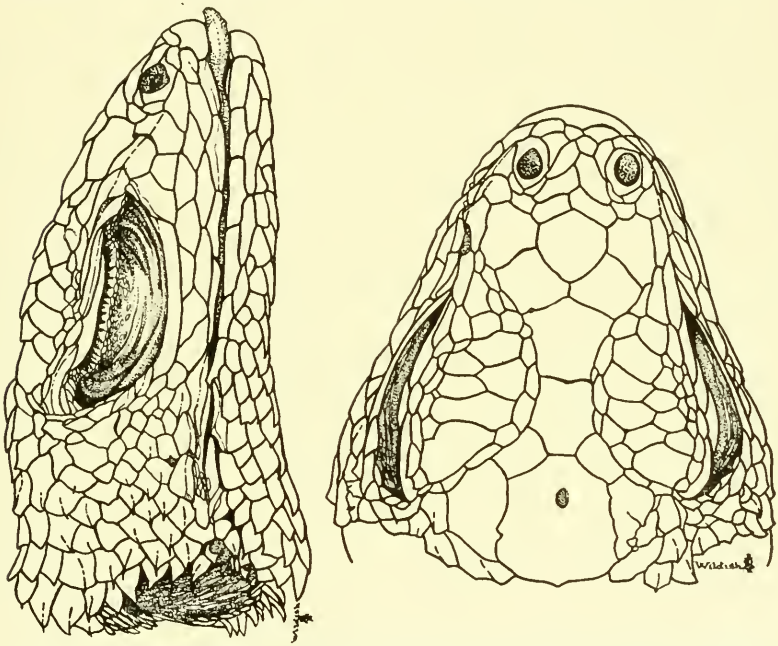

FIG. 20. Head scales of *Sceloporus jarrovii immucronatus* Smith. EHT & HMS 500, El Pinalito, Hidalgo; actual head length, snout to occiput, 16.5 mm.

parietal; frontal transversely divided; two prefrontals, in contact on median line; three frontoparietals, the lateral in contact with both canthals; three pairs of small internasals, the posterior largest, the anterior smallest; a single small scale, not entering into series surrounding nasal, separates the posterior internasal from the first canthal; five scales, including the subnasal, surround the nasal; four supra- and five infralabials to a point below the middle of the eye.

Mental rather U-shaped, its labial border almost equal to that of rostral; mental followed by a series of five or six enlarged scales on each side, the anterior in contact with its fellow on the median ventral line; this series of scales separated from infralabials anteriorly by a single row of elongate scales (except anterior scale,

which is in contact with the first infralabial), posteriorly by two rows, the second row beginning below the junction of the second and third infralabials and in contact with the series of postmental scales; scales in temporal region keeled, mucronate in area near ear; anterior margin of ear with five smooth, pointed scales, on one side the upper two much larger than the others, on the other side all five approximately equal in size, the upper two but little larger than the others and smaller than the preceding scales (subequal on one side); lateral cervical pouch present, a fold from about its middle to lower margin of ear; this fold surmounted by scales more strongly mucronate than those adjacent and somewhat smaller than those in region near angle of jaw; dorsal scales in parallel or weakly converging rows, very weakly keeled, weakly mucronate; lateral scales more strongly keeled and mucronate, somewhat smaller than dorsals and in diagonal rows; laterals with as many as seven mucrones; dorsal scales a little more than half as large as largest caudals; ventrals relatively large, about one half the size of dorsals; breast scales no larger than those in median abdominal area; ventral scales in anterior region, near chin, smaller than gular scales nearer gular fold region; the latter scales as large as those in region near angle of jaw; median gular scales about as large as abdominals; preanals about as large as gulars; ventrals emarginate.

Scales on dorsal surface of upper foreleg somewhat smaller than those on back, those on dorsal surface of lower foreleg considerably smaller; all dorsal scales of arm, except hand, keeled and mucronate; ventral scales of lower forearm somewhat smaller than dorsals of the same member, those on ventral surfaces of upper forearm much smaller; all ventral scales of arm, except hand, smooth; one dorsal, two lateral, and one ventral row of scales around fingers and toes, all continuous to tip except the two laterals, which terminate behind the last scale of the other series; lamellar formula for fingers 9-13-18-19-14; dorsal scales of hind limbs keeled, mucronate, less so on foot; dorsals of tibia of about the same size as dorsals on body, those on femur somewhat smaller; ventral scales of hind limb, except foot, smooth; ventrals of tibia somewhat smaller than dorsal scales of the same member; scales on anterior surface of femur smooth, becoming progressively smaller toward the femoral pore series; scales immediately anterior to femoral pore series somewhat smaller than preanals; scales on posterior surface of femur keeled, mucronate, smallest near femoral pores, and becoming progressively larger toward dorsal surface; scales immediately posterior to femoral pore series about one third to one half as large as those immediately

anterior to pore series; lamellar formula for toes 9-14-20-23-16; a pair of distinctly enlarged postanals; caudals strongly keeled and mucronate except those on ventral surfaces.

Color. General dorsal ground color cobalt blue of varying degrees of brilliance; this color uniform, without markings, over dorsal surfaces of tail, limbs and back as far forward as neck. A narrow black neckband is present, two or three scales wide, bordered behind and in front by relatively broad pale-blue bands about two scales wide; the black collar passes onto shoulder, widens there somewhat, then becomes narrow and is complete across the gular region. The dorsal surface of the neck and head anterior to the nuchal collar is darker blue (berlin or indigo blue), with irregular pale-blue spots. A broad pale-blue band begins on the rostral and passes over the supralabials, including the subocular, broadens in the temporal region and passes through the ear, covering the entire opening. This band unites with the light anterior border of the nuchal collar. The area anterior to the gular fold is uniform ultramarine blue; a broad central band down the belly is grayish, with very dark-blue edges, which in turn border on lateral lighter blue areas of slightly darker blue than the dorsal ground color. The ventral surfaces of the limbs are light blue, a narrow edge of each scale usually white; the ventral surface of the tail is pale blue, with a suffusion of white in some areas.

Variation. The outer row of enlarged supraoculars (the smaller of the two rows) is frequently fused in part with the inner row, but never is there but a single row. The outer row is formed of scales of varying sizes, sometimes almost as large as the scales of the inner row, sometimes much smaller. In four specimens the frontal is in contact with the interparietal; in one the two frontoparietals are in contact; in the remainder of the series a single, small, median scale separates the frontal from the interparietal; of the specimens with the latter arrangement, there are three in which the posterior section of the frontal is divided transversely, and the posterior scale of these two is divided longitudinally. In all paratypes the loreal is in contact with the subnasal, the first canthal never (except in holotype) contacting the series of small scales above the supraoculars; the preocular is separated from these latter series of scales in seven specimens; the first canthal is always distinct, never confined to the area above the canthal ridge. The posterior pair of internasals is in contact with the first canthal in three specimens; there are three pairs of internasals, as in the type, in only three paratypes; in nine others there are two distinct pairs, and in the remainder of the series the

scales are irregular. The median frontonasal contacts the frontal in one specimen, and is separated from the frontal in another specimen by a small scale intercalated between the two prefrontals.

The two rows of scales between the subocular and superior labials are reduced to one at one point on both sides in nine specimens, on one side in four. The medial of the two rows of scales intercalated between the postmentals and inferior labials extends anteriorly to the anterior half of the second infralabial in one count (two counts per specimen); to the middle of the second in one; to the posterior half of the second in five; to the suture between the second and third in fourteen; to the anterior half of the third in nineteen; to the middle of the third in one; to the suture between the third and fourth in four; and to the anterior half of the fifth in one.

The dorsal scale rows are distinctly converging in seven specimens. In the remainder they are either parallel or very slightly converging (one row dropping out).

The dorsal coloration of the males is almost identical with that of the holotype. The light borders of the nuchal collar are in some specimens broken; the posterior border may be broken medially, and the anterior may be broken into a series of large light spots. The general bluish coloration of the throat is hardly developed in small specimens, but distinct in those about 70 mm. from snout to vent and larger. The blue of the sides of the belly is continuous with the dorsal and lateral ground color. The neckband is complete around the gular fold region in specimens 70 mm. from snout to vent and larger.

The dorsal coloration of the females is essentially like that of the males. The ground color, however, is grayish instead of blue, and there are present in all but the largest specimens indistinct black spots scattered over the dorsal and lateral surfaces of the body. They are larger on either side of the middorsal line and tend to form two longitudinal rows. The tail is indistinctly banded. The ventral coloration is light, sometimes suffused with bluish in the lateral abdominal regions.

The most characteristic feature of the coloration is the brilliant blue ground color, which is varied only with black. The blue is less distinct in females than in males, but even in these blue forms an essential element of the coloration.

Remarks. *S. j. immucronatus* is most closely related to *cyanogenys* and *minor*. No specimens have been examined which show intergradation with either, however, and it is rather difficult to determine

from which it has been derived. I have concluded for the present that *immucronatus* is derived from *minor*. Geographical association points toward such a conclusion, as well as general form, maximum size, character of the preocular and average scale count from occiput to base of tail. It conforms more closely to *cyanogenys* in color, character of the supraoculars and number of femoral pores.

Summarizing the points of distinction between *minor* and *immucronatus*, the following may be mentioned: Ratio of hind leg to snout-vent measurement greater in *immucronatus* (64.0 to 71.3, average 66.0 in the latter; in *minor*, 61.2 to 67.5, average 63.4); supraoculars irregular in *immucronatus* (as in *cyanogenys*); femoral pores usually more numerous (rarely more than 14 in *minor*, rarely less in *immucronatus*); enlarged postanals present and well developed in males of *immucronatus*, variable in *minor*. In color *immucronatus* differs by having a distinctly narrower black nuchal collar, a general ground color of blue, and much black in the ventral coloration of males.

From *cyanogenys*, *immucronatus* differs in possessing a larger number of scales from occiput to base of tail (37 to 46 in *immucronatus*, 32 to 40 in *cyanogenys*), preocular usually not divided (usually divided in *cyanogenys*), ratio of hind leg to snout-vent measurement greater (58.6 to 66.9, average 64.6), and lesser maximum size (86.0 mm. snout to vent in *immucronatus*, 143 mm. *in cyanogenys*). In color, the males of *immucronatus* differ by having much black in the ventral coloration; *cyanogenys* does not.

Habits and habitat. The specimens from Hidalgo were collected on granite rocks on the crest of the plateau edge. The males, with their brilliant blue coloration, were conspicuous from a considerable distance.

A number of very young specimens were collected with the adults, and it is assumed from this that *immucronatus* is ovoviviparous, as are other members of the *torquatus* group.

Range. Western Querétaro through Hidalgo to southern central Vera Cruz. (See fig. 17 for distributional map.)

Locality records. El Pinalito, Hidalgo (EHT & HMS 498-504, 506-508, 510-511); twenty-five miles south of Jacala, Hidalgo (EHT & HMS 605-615); Presidio, north of Montzorongo, Vera Cruz (MCZ 21093, W. W. Brown); Pinal de Amoles, Querétaro (USNM 47776, Nelson & Goldman).

Measurements and Scale Counts of *Sceloporus jarrovii immucronatus* Smith

Museum	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	MCZ	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS
Number	498	500	499	605	21093	606	502	607	508	506	501	507	609	503	511	610
Snout to vent	87.0	86.0	84.5	78.0	77.0	75.0	75.0	75.0	74.5	72.0	71.5	68.0	67.5	66.0	61.5	60.0
Tail	143.0	126.0	.....	.....	.....	.....	.....	reg.	reg.	.....	.....	.....	.....	101.0	96.0	90.0
Snout to occiput	16.0	16.5	.....	14.0	13.6	14.0	14.5	14.0	13.8	13.0	14.6	13.0	12.7	12.5	12.0	12.0
Snout to ear	20.5	20.0	.....	17.8	18.0	18.5	18.5	17.5	17.5	16.0	17.5	16.0	15.8	15.5	15.0	14.5
Hind leg	58.0	56.5	57.5	52.0	.....	50.0	48.0	49.5	48.0	50.0	51.0	44.5	45.0	45.5	40.5	42.0
Tibia	17.0	17.0	16.5	15.8	14.9	15.8	14.5	14.5	13.9	15.0	14.5	13.0	13.0	13.5	12.0	12.0
Fourth toe	21.0	21.0	21.0	19.0	17.9	19.0	19.0	18.4	18.3	17.5	20.5	17.9	17.0	17.0	16.0	15.0
Fifth toe	11.2	11.8	12.0	10.2	9.1	10.0	10.5	10.1	10.4	9.5	11.0	8.7	9.3	8.9	9.2	8.7
Lamellae, fourth toe	23	23	21	20	19–19	20	20	21	20	22	23	20	19	21	22	20
Femoral pores	16–17	12–14	14–14	12–12	14–14	15–17	16–16	15–16	17–17	17–17	16–?	15–?	16–16	17–20	15–17	15–16
Dorsals	43	43	41	43	43	40	46	43	42	45	42	40	40	43	40	39
Ventrals	62	54	51	60	55	53	58	54	55	57	63	56	48	60	56	52
Scales around body	53	44	48	43	47	43	45	42	45	47	50	45	41	48	45	43
Scales to head length	9.0	9.0	10.0	8.0	7.0	7.5	9.5	8.0	7.5	7.0	10.0	8.0	7.5	8.0	8.0	8.0
Ratio, hind leg to snout-vent	66.6	65.6	68.0	66.6	.....	66.6	64.0	65.7	64.4	69.4	71.3	65.4	66.6	68.9	65.8	70.0
Ratio, fourth toe to snout-vent	24.1	24.4	24.8	24.3	23.2	25.3	25.3	24.5	24.5	24.3	28.6	26.3	25.1	25.7	26.0	25.0
Sex	♂	♂	♂	♂	♀	♂	♂	♂	♀	♀	♂	♀	♀	♀	♀	♀

Sceloporus ornatus ornatus Baird

(Text Figs. 21 and 22; Plate LIV, Fig. 1)

Sceloporus ornatus Baird, 1859, p. 254; *idem*, 1859a, pp. 5-6; Müller, 1865, p. 602; Cope, 1875, p. 48; Yarrow, 1883, p. 57; Garman, 1884, p. 17; Boulenger, 1885, p. 224; Cope, 1885, p. 403; *idem*, 1887, p. 38; Boulenger, 1890, p. 78; Günther, 1890, pp. xii, 72; Boulenger, 1897, pp. 485-486; Cope, 1900, pp. 335, 340, 344-345, Fig. 48; Strecker, 1915, pp. 19-20; Stejneger, 1916, pp. 227, 228.

Type locality. Patos, Coahuila. Holotype USNM 2845, Lt. B. Couch, collector.

Diagnosis. A member of the *torquatus* group; dorsal scales 55 to 63 from occiput to base of tail; supraoculars quite irregular or in two rows; posterior section of frontal reduced in size, broken in small scales or absent; lorilabials usually reduced to one row below subocular; two canthals, normal in position; inner row of labiomentals terminating below third infralabial; femoral pores 16 to 20 (rarely 14 or 15); ratio of hind leg to snout-vent measurement, 61.4 to 65.5; ratio of fourth toe to snout-vent measurement, 20.2 to 24.4; tibia longer than snout-occiput measurement; length of fourth toe usually somewhat less than snout-ear measurement. Neckband narrow, four to seven scales wide, with narrow light borders two scales wide; back dimly banded; throat uniform white in females, pale blue in males, without darker markings; males with sides of belly, from axilla to groin, caerulean blue, bordered medially by a hyacinth blue line; the blue area on the sides of the belly are separated by eight to twelve scale rows.

Description (from EHT & HMS 4420, male). Head and body strongly depressed; scales of head pitted, the scales in prefrontal and internasal region more strongly; cephalic scales smooth; interparietal pentagonal, four times as large as either parietal; parietals single on either side, subtriangular; frontoparietals single on either side, rectangular, about two fifths the size of parietal; frontoparietals separated medially by an azygous scale; posterior section of frontal split irregularly into three scales; prefrontals as large as lateral frontonasals, in contact medially; frontonasals approximately equal in size; internasals irregular, separated from rostral by a single row of small scales; nasal small, subcircular, separated from rostral; supraoculars irregularly divided, small; a row of scales separating supraoculars from median head scales, and one complete and another incomplete row between supraoculars and superciliaries; two canthals, the first smaller than the second, second canthal not in contact with subnasal; first canthal not touching lorilabials; loreal rectangular, somewhat larger than subnasal, preocular completely divided on one side, partially on the other; subocular

followed by three small, well-differentiated, keeled postoculars; lorilabials in two complete rows below subocular, reduced to one at a narrow point on one side; three and one half supralabials and four and one half infralabials to a point below middle of eye.

Mental with a labial border about two thirds that of rostral; mental pentagonal, followed by several pairs of postmentals, the anterior two pairs well differentiated, and the scales of the anterior pair in contact; outer row of labiomentals separated from mental by partial contact of first postmental and first infralabial; gular scales

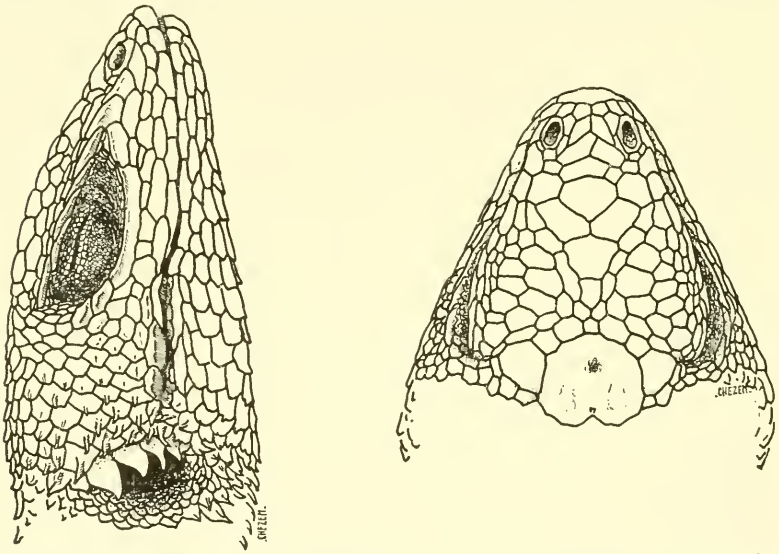

FIG. 21. Head scales of *Sceloporus ornatus ornatus* Baird. EHT & HMS 4422, near Saltillo, Coahuila; actual head length, snout to occiput, 12 mm.

smooth, rounded except in extreme posterior part of the gular region, where they are weakly notched; gular scales smallest in middle of throat, largest toward angle of jaws.

Three or four auricular lobules, smooth, the lower one or two pointed, the upper two rounded and nearly twice as large as preceding scales; temporal scales very weakly keeled and very weakly mucronate, becoming more strongly keeled and mucronate toward ear; temporal scales subequal in size to scales between ear and lateral nuchal fold; a fold of skin between upper edge of lateral nuchal fold and lower edge of ear, surmounted by strongly keeled, very strongly mucronate scales; nuchal fold or pouch moderately deep; dorsal scales not or but very weakly keeled, not or but very weakly mucronate, not denticulate; lateral scales keeled, mucronate, weakly

denticulate, the largest slightly larger than median dorsal scales; ventral scales smooth, rounded, about two thirds the size of median dorsal scales; ventral scales on chest slightly larger than median ventral abdominals; scales in preanal and interfemoral regions slightly smaller than preceding scales; postanal scales enlarged, separated by two small scales; subcaudals smooth except toward tip of tail; dorsal caudals near base of tail about twice as large as median dorsals on body.

Dorsal scales of foreleg as large as or larger than median dorsals on body, those on upper foreleg somewhat larger than those on lower foreleg, all keeled and mucronate; scales on anteroventral surface of lower foreleg smooth, rounded or weakly mucronate, somewhat smaller than dorsal scales of same member; scales on posteroventral surface of lower foreleg somewhat larger, keeled, mucronate; ventral scales of upper foreleg smooth, rounded, about one third size of dorsals of same member; scales in axilla not granular; lamellar formula for fingers, 8-12-16-16-12 (7-12-16-16-13).

Dorsal scales of thigh about as large as median dorsals of body, keeled, mucronate; dorsal scales of shank nearly twice as large as median dorsals on body, keeled, strongly mucronate; ventral scales of shank about two thirds size of dorsal scales of same member, smooth, rounded; scales on ventral surface of femur near series of femoral pores subequal in size to preanal scales, smooth, rounded or weakly notched; scales on posterior surface of femur somewhat larger than preanal scales, keeled, mucronate, abruptly decreasing in size toward series of femoral pores; no postfemoral dermal pocket; lamellar formula for toes, 8-12-19-20-15 (8-12-18-20-15).

Color. The dorsal coloration is practically identical in all. A very distinct black band crosses the neck and passes onto the shoulder. It is four to seven scales long on the median dorsal line, and is bordered on both sides by a broad light line, covering about two scale rows, of a whitish or iridescent pale-blue color, sometimes with a tinge of orange laterally. Both light lines may be complete or either one or both broken on the median line. The area between the neck band and frontal region, as well as the temporal region, is variously marked; in some females no markings are present there, while in males this area is spotted with whitish or iridescent pale blue, sometimes forming an indistinct light band across the neck. The back is sepia in females, more or less black in males. About seven indistinct, broken, narrow light bands traverse the back, disappearing on the sides, which are lighter in color than the median dorsal area. The sides are usually pale blue, suffused to a varying

degree with orange, but in some females are brownish, somewhat lighter than the back. In some males the lighter color of the sides encroaches on the median darker area, resulting in a pattern of a series of paired dark spots down the middle of the back. The tail is dimly barred with usually rather narrow, light bands alternating with much broader dark bands.

In males, the throat and gular regions are pale blue; the sides of the belly, from axilla to groin, are caerulean blue, bordered medially

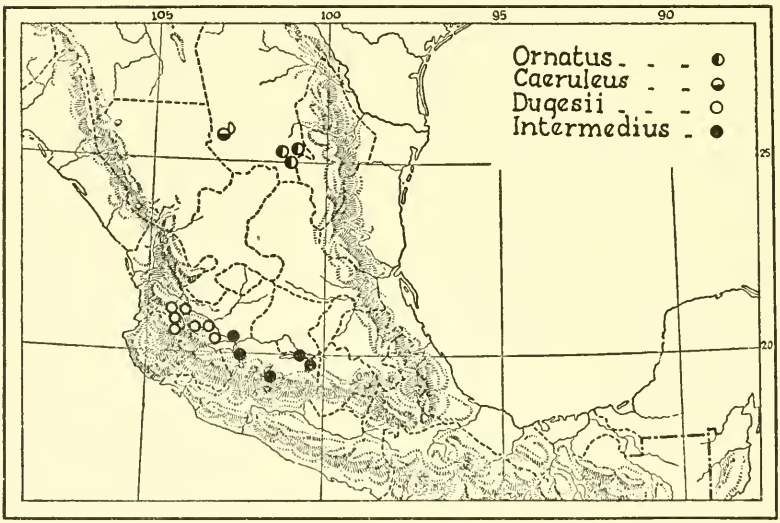

FIG. 22. Distribution of *Sceloporus ornatus ornatus* Baird, *S. o. caeruleus* Smith, *S. dugesii dugesii* Bocourt and *S. d. intermedius* (Dugès).

by a hyacinth blue line; the blue areas on the sides of the belly are separated by eight to twelve scale rows.

Variation. Only eight specimens have been available for a study of variation. Parietal one fourth to one fifth size of interparietal; frontoparietal divided on both sides in one, on one side in two; frontal never touches interparietal; frontoparietals contact medially in two; an azygous scale separates frontoparietals in six; frontal variously divided, normally divided in two specimens; supraoculars divided in all; prefrontals contact in all; canthals 2-2 in all, normal in relationship to other scales; preocular divided on both sides in two, on one side in one; scales below subocular not reduced to one row at a point below subocular on one side in one specimen; outer labiomental row separated from mental in all; inner row of labiomentals terminating at a point even with the anterior half of third

infralabial (middle of third infralabial on one side of one and on both sides of another).

Auricular lobules three to five, usually the latter number, the upper three lobules largest; femoral pores 16 to 20 (14-15 in one specimen); dorsals from occiput to base of tail 55 to 63.

Remarks. The species is apparently confined to semiarid localities. The specimens collected near Saltillo were found by Edward H. Taylor near the crest of a high hill at the north edge of the city.

Range. Known only from southeastern Coahuila.

Locality records. Coahuila: Patos (USNM 2845; Lt. Couch); near Saltillo (EHT & HMS 4300, 4418-4422, 4598); four to five miles north of Gomez Farias (EHT & HMS 4301); Jaral (FMNH 1548, Heller & Barber). Published records are available from Redmond's Pass, Texas (Cope, 1900); Nuevo León (Boulenger, 1890, 1897; Günther, 1890); Duvall Co., Texas (Boulenger, 1897). Stejneger (1916) states that the records from the latter two localities are based upon *Sceloporus disparilis*. Cope's specimen cannot now be found. Garman (1884) gives the locality "Sonora"—undoubtedly incorrect.

Measurements and Scale Counts of *Sceloporus ornatus ornatus* Baird

Museum	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	EHT & HMS	USNM
Number	4422	4598	4420	4421	4418	2845
Snout to vent	63.5	67.0	72.5	73.5	74.0	82.5
Tail	.....	82+	109.0	.....	.....	.....
Snout to occiput	12.0	12.0	13.2	13.5	13.0	15.2
Snout to ear	16.0	16.0	18.0	17.5	17.0	19.4
Hind leg	?	43.0	47.5	.....	43.0	51.4
Tibia	?	13.0	16.2	.....	14.0	16.5
Fourth toe	15.2	15.0	17.0	18.0	15.0	17.6
Fifth toe	7.2	7.6	8.7	9.2	8.2	9.6
Lamellae, fourth toe	20–19	18–19	19–19	19–18	19–19	20–20
Femoral pores	16–16	16–17	18–19	20–19	17–18	15–17
Dorsals	56	55	63	55	58	60
Ventrals	60	65	72	74	70	76
Scales around body	54	57	57	54	57	61
Scales to head length	10.5	9.5	13.0	11.0	10.5	11.0
Ratio, hind leg to snout-vent	.....	64.1	65.5	.....	61.4	62.4
Ratio, fourth toe to snout-vent	23.9	22.3	23.4	24.4	20.2	21.3
Sex	♀	♀	♂	♂	♀	♂

Sceloporus ornatus caeruleus Smith

(Text Figs. 22 and 23; Plate LIV, Fig. 2)

Sceloporus ornatus caeruleus Smith, 1936a, pp. 227-230.

Type locality. Five miles south of San Pedro, Coahuila, Mexico. Holotype DHD & HMS 350; paratypes DHD & HMS 348-9, 351-361; David H. Dunkle and H. M. Smith, collectors.

Diagnosis. A member of the *torquatus* group of *Sceloporus*; dorsal scales, 47 to 53 from occiput to base of tail; posterior section of frontal reduced or variously divided; supraoculars in two rows, the scales of the outer row somewhat smaller than those of the inner row; lorilabials reduced to one row at a point below subocular; two canthals, normal in position; inner row of labiomentals terminating below third infralabial; femoral pores 12 to 17 (average 13.7); ratio of hind leg to snout-vent measurement, 66.6 to 74.5; ratio of fourth toe to snout-vent mesaurement 22.7 to 27.4; length of tibia greater than snout-occiput measurement; length of fourth toe usually slightly greater than snout-ear measurement, sometimes equal or slightly less. General ground color bluish; nuchal collar four to six scales wide, light bordered; ventral surfaces of males entirely blue, without darker markings; a series of about seven dark blotches more or less evident on middle of back.

Description of holotype. Head and body somewhat compressed; scales of head not rugose or keeled; scales in prefrontal, frontonasal and internasal regions rather strongly pitted; a few pits on other head scales; parietals single on either side, subtriangular, about one third size of interparietal; interparietal pentagonal, the posterior edge rounded and confluent with posterior edges of parietals; frontoparietals small, square, separated medially by a small azygous scale; another small scale between frontal and right frontoparietal; posterior section of frontal slightly less than one third size of anterior section; prefrontals in contact medially, but slightly smaller than anterior section of frontal; lateral frontonasals subequal in size to prefrontals; median frontonasal somewhat larger; scales in internasal region irregular; nasal small, the anterior border about nostril somewhat wider than posterior border; nasal separated from rostral; supraoculars in two rows, the scales of the outer row about half as large as scales of inner row; one complete and another incomplete row of scales between supraoculars and superciliaries; one row of rather broad scales between supraoculars and median head scales; six superciliaries, the fifth entirely concealed by the fourth, which is abnormally divided into two; two canthals, normal in position, the first somewhat smaller than the second; subnasal smaller than loreal,

which is very long and narrow; preocular not divided; subocular followed by two small, well-differentiated, strongly keeled postoculars; lorilabials reduced to one row by two scales below subocular.

Mental subtriangular (tending toward pentagonal), with a lateral border slightly more than one half that of rostral; mental followed by about four pairs of postmentals; scales of first pair of postmentals in contact medially; outer row of labiomentals separated from mental by partial contact of first postmental and first infralabial; inner row of labiomentals terminating at a point even with anterior half of third infralabial; median gular scales about one third smaller than lateral gular scales; scales in anterior part of gular area with a terminal pit, those in extreme posterior part of gular area notched.

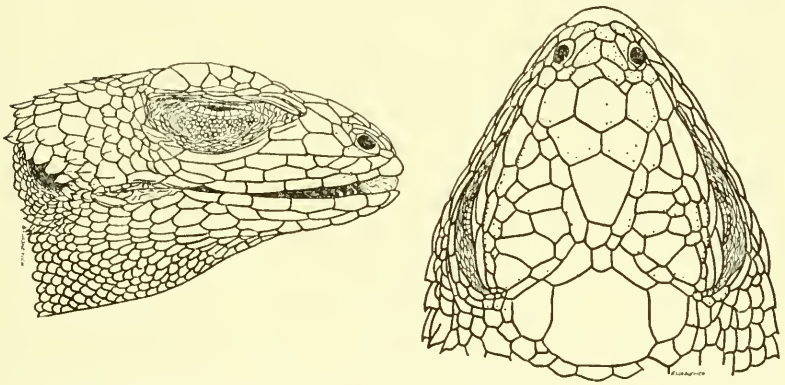

FIG. 23. Head scales of *Sceloporus ornatus caeruleus* Smith. DHD & HMS 355, five miles south of San Pedro, Coahuila; actual head length, snout to occiput, 11.5 mm.

Auricular lobules three or four, distorted on one side; on the other side the median two are much larger than the outer two, rounded, not keeled, subequal in size to scales in temporal region; scales between ear and lateral nuchal fold one third or one fourth the size of scales in temporal region; latter scales keeled, denticulate, mucronate; a weak skin fold between upper edge of lateral nuchal pocket and lower edge of ear, surmounted by small, very strongly keeled and mucronate scales; median dorsal scales smooth, sometimes rounded, usually with one or two terminal pits or denticulations, rarely with a terminal mucrone; lateral scales somewhat smaller than median dorsal scales, keeled, mucronate, denticulate, with terminal pits; median abdominal scales about one third to one half the size of median dorsal scales, somewhat larger than preanal scales; scales on chest slightly larger than those in middle of belly; scales on abdomen and on chest smooth, rounded; enlarged postanals

present, separated by two scales; subcaudals smooth except toward extreme tip of tail; dorsal caudal scales near base of tail slightly larger than median dorsals on body.

Dorsal scales of foreleg somewhat smaller than dorsal scales on body, keeled, mucronate, with terminal denticulations and pits; scales on lower foreleg somewhat smaller than those on upper; ventral scales of foreleg smooth, notched or with terminal pits, those on lower foreleg somewhat smaller than dorsal scales of same member; ventral scales on upper foreleg about half as large as ventral scales of lower foreleg; lamellar formula for fingers, 10-14-17-18-13 (9-14-18-18-13).

Dorsal scales of hind leg keeled, mucronate, denticulate and with terminal pits; dorsal scales of tibia somewhat larger than dorsals on body, those on femur slightly smaller; ventral scales of hind leg smooth, rounded or notched; ventral scales of shank slightly smaller than dorsal scales of the same member; ventral scales in front of femoral pore series subequal in size to preanal scales, gradually increasing in size toward anterior face of femur; scales on posterior surface of femur strongly keeled, strongly mucronate, slightly larger than preanal scales, abruptly decreasing in size immediately posterior to femoral pore series; no postfemoral dermal pocket; lamellar formula for toes 7-13-17-20-16 (7-13-18-20-16).

Color. General dorsal color pale blue, with a greenish suffusion; a series of large black blotches, about six in number, of indefinite outline, on middle of back, separated from each other by one row of light scales; nuchal collar four scales wide, with light anterior and posterior borders about two scales wide; posterior light border extending onto proximal end of forearm; anterior border terminating on sides of neck slightly above and posterior to lateral nuchal fold; a light bar across neck between ear and foreleg, terminating on sides of neck about at a level with upper edge of ear; an indistinct, broken light line across neck between upper edges of ear; a few light-colored scales in temporal region; limbs dimly banded.

Black nuchal collar continuous about neck; a suffusion of black in groin, extending somewhat on ventral surface between groins; entire ventral surfaces of other parts, including head, limbs and tail, bluish; the sides of the belly, lower surfaces of hind limbs, median gular area and basal region of tail grey smalt blue; lower surfaces of forelegs and distal part of tail suffused with pale blue; median anterior abdominal and anterior gular regions suffused with iridescent apple green; ventral surfaces of hands and feet white.

Variation. The dorsal coloration of all paratypes is much as in the holotype. In females the general ground color is less brilliant. The ventral coloration of the males is much as in the holotype. In younger males the ventral surface of the tail, hind limbs and an indistinct, narrow median area in middle of abdomen are whitish. Females are whitish below, without dark markings, sometimes with a general light suffusion of pale blue.

The parietals are from one third to one sixth the size of the interparietal; the frontoparietals are divided on one side in one, on both sides in another (in the latter specimen, the posterior part of each divided frontonasal is fused with the interparietal); the frontal touches the interparietal in two; the frontoparietals contact medially in one; an azygous scale lies between the frontoparietals in nine; the posterior section of the frontal is divided into two scales in five specimens; in one the posterior section is absent; in seven the frontal is normally divided, the posterior part always considerably smaller than the anterior; the supraoculars are always in two rows, the scales of the outer row smaller than those of the inner; the row of scales separating the supraoculars from the median scales is always composed of broad, not elongate, scales; all supraoculars separated from median head scales; prefrontals in contact in all; invariably two canthals, normal in position and relationships with other scales; preocular divided in eight; lorilabials reduced to one row at a point below subocular in all; outer row of labiomentals terminating below anterior half of third infralabial in all but two; in one of these it terminates below the posterior half of the third, in the other it terminates below the anterior half of the fourth.

Auricular lobules three to five, usually with two much larger than the others; dorsal scales 47 to 53, average 49.7; femoral pores 12 to 17, average 13.7. Other characters of scalation approximately as in holotype. Variations in proportions and certain scale characters are given in the accompanying table.

Habits. Specimens of this subspecies were found on large rocks on the north exposure of a range of low, arid hills a short distance north of the road from Torreón to Saltillo, about five miles south and slightly east of San Pedro. Peculiarly enough, the species was not found on a somewhat higher range of hills a short distance south of the road; it is possible that it was not sufficiently warm when Mr. Dunkle and I collected there. It was about 11:00 a. m. when the lizards were encountered in relative abundance. They were extremely wary, and could be collected successfully only by sighting

Measurements and Scale Counts of *Sceloporus ornatus caeruleus*—Smith

Number	360	361	359	351	349	348	355	354	353	350
Snout to vent	50.2	54.5	57.5	59.0	59.0	62.5	63.0	66.0	66.5	75.0
Tail	81.0	.....	.....	.....	100.0	.....	.....	.....	.....	.....
Snout to occiput	10.3	11.0	12.0	12.5	12.0	12.0	11.5	12.6	12.5	14.0
Snout to ear	13.0	14.0	15.0	16.0	15.0	16.0	15.0	16.2	16.5	17.5
Hind leg	34.5	39.5	38.5	44.0	44.0	42.0	42.5	44.0	47.0	50.0
Tibia	11.0	12.2	12.5	13.0	12.8	12.0	13.0	13.5	13.0	15.0
Fourth toe	13.0	14.3	15.5	16.2	15.8	15.9	15.5	15.0	17.0	17.0
Fifth toe	6.8	7.4	8.1	8.0	8.6	8.2	8.2	7.7	9.0	9.4
Lamellae, fourth toe	19–19	19–20	19–18	19–18	20–21	22–20	23–23	19–19	21–21	20–20
Femoral pores	13–14	14–17	12–13	14–16	14–16	12–14	15–16	13–13	12–13	13–13
Dorsals	52.0	47.0	51.0	51.0	47.0	51.0	53.0	53.0	48.0	48.0
Ventrals	67.0	60.0	63.0	66.0	59.0	58.0	62.0	67.0	61.0	59.0
Scales around body	55.0	47.0	52.0	53.0	50.0	47.0	46.0	54.0	48.0	49.0
Scales to head length	11.0	11.0	11.0	12.0	11.0	9.5	9.5	10.0	10.0	9.5
Ratio, hind leg to snout-vent	68.7	72.4	66.9	74.5	74.5	67.2	67.4	66.6	70.6	66.6
Ratio, fourth toe to snout-vent	25.8	26.2	26.9	27.4	26.7	25.4	24.6	22.7	25.5	23.3
Sex	♀	♀	♂	♂	♂	♀	♀	♂	♂	♂

them at a considerable distance and then approaching as cautiously as possible. The brilliant ventral coloration of the males was very conspicuous as they protruded their heads and breasts above the edges of rocks.

Range. Known only from the type locality. (See fig. 22 for distributional map.)

Sceloporus dugesii dugesii Bocourt

(Text Figs. 22 and 24; Plate LV, Fig. 1)

Sceloporus dugesii Bocourt, 1874, pp. 188-190, pl. 18, figs. 7, 7a, 7b; Garman, 1884, p. 18; Boulenger, 1885, pp. 224-225; Günther, 1890, p. 71.

Sceloporus pleurolepis Günther, 1890, pp. xii, 74-75, pl. 32, fig. B.

Sceloporus yarrovii Günther, 1890, pp. xii, 69 (part); Boulenger, 1897, pp. 483-385 (part).

Type locality. Colima.

Diagnosis. A member of the *torquatus* group of the genus *Sceloporus;* dorsal scales, 41 to 50 from occiput to base of tail; lateral scales considerably larger than median dorsal scales, in oblique rows, and each with an apical mucrone arising within the free margin of the scale; ratio of hind leg to snout-vent measurement, 52.5 to 61.7; ratio of fourth toe to snout-vent measurement, 17.4 to 24.1; fourth toe shorter than distance from snout to posterior border of ear; femoral pores, 9 to 13; head scales rugose (microscopically); posterior section of frontal reduced; supraoculars in two irregular rows; frontoparietals rarely in contact medially; black nuchal collar narrow, three or four scales wide, with a light posterior border not over a scale wide, passing onto shoulder; anterior light border of collar absent or indistinct; a dim, dark line from eye through upper part of ear to collar, bordered above and below by a narrower light line; back uniform gray or with indistinct darker spots; throat not conspicuously barred. Maximum snout-to-vent measurement, 87.5 mm.

Description (from EHT & HMS No. 2759, male). Head and body flattened; head scales rugose and pitted; a single rounded parietal on each side; interparietal pentagonal, about three and one half times as large as either parietal; a single frontoparietal on each side, rectangular, about two thirds as large as either parietal; frontal touching interparietal, separating frontoparietals medially; posterior section of frontal about two fifths the size of anterior section; prefrontals slightly more than half the size of anterior section of frontal, separated medially by narrow contact of frontal and median frontonasal; latter separated on each side from lateral frontonasals by a small, elongate scale; a pair of rather large scales preceding median frontonasal, in turn preceded by a pair of large

internasals separated from rostral by a pair of small, narrow scales; supraoculars six or seven, divided, separated from median head scales by a row of small scales, from superciliaries by one complete and another incomplete row of scales; nasal small, separated from rostral, the portion anterior to naris strongly tapered but much broader than part posterior to naris; subnasal present, moderate in size; a single loreal on each side, about equal in size to subnasal; preocular large, not divided; two canthals, the first not forced above

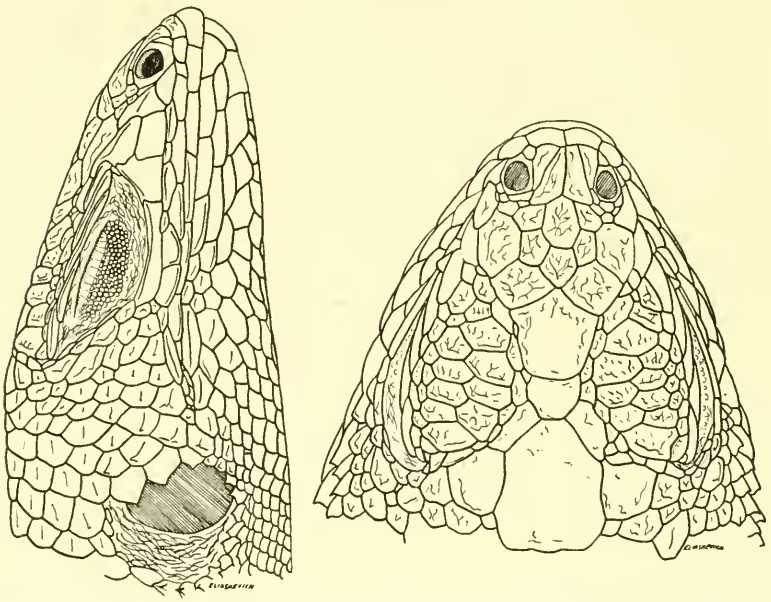

FIG. 24. Head scales of *Sceloporus dugesii dugesii* Bocourt. EHT & HMS 2761, near Magdalena, Jalisco; actual head length, snout to occiput, 15.7 mm.

canthal ridge nor contacting lorilabials; subocular normal, followed posteriorly by two well-differentiated, strongly keeled postoculars; rows of lorilabials reduced to one at a point below subocular; about four infra- and supralabials to a point below middle of eye.

Mental pentagonal, with a labial border about two thirds that of rostral; about three pairs of well-differentiated postmentals, the scales of the anterior pair in contact medially; outer row of labiomental scales narrowly separated from mental by partial contact of first infralabial and first postmental; inner row of labiomental scales terminating anteriorly below the posterior part of second infralabial; gular scales smooth, rounded except in extreme posterior part of gular region, where they have a single, small, apical notch.

Three or four auricular lobules, the upper ones smooth and rounded, the lower ones acuminate, all smaller than preceding scales; temporal scales keeled, not mucronate; scales between ear and lateral nuchal fold somewhat larger than in temporal region, keeled and strongly mucronate; lateral nuchal fold strongly oblique; dorsal scales weakly keeled, not mucronate; lateral scales in oblique rows, nearly twice as large as median dorsals, keeled, rather strongly mucronate, with the apical mucrone of each arising within the free edge of the scale; ventral scales rounded or very weakly notched, about one third the size of median dorsals; preanal scales as large as or slightly larger than median ventral abdominals; scales between hind legs about half the size of preanals; scales on anterior part of chest slightly larger than the scales posterior; subcaudals smooth except toward tip of tail; postanals enlarged, separated by a pair of small scales; dorsal caudals near base of tail about twice as large as median dorsals on body.

Dorsal scales of foreleg subequal in size, about equal to dorsals on body, keeled, weakly mucronate; ventral scales of foreleg very weakly keeled or smooth, weakly mucronate, those on lower foreleg about one third larger than those on humerus and somewhat smaller than dorsals of foreleg; lamellar formula for toes, 8-12-16-17-12 (9-13-17-16-11).

Dorsal scales of hind limb keeled, strongly mucronate, those on femur subequal in size to dorsals on body and somewhat smaller than those on tibia; ventral scales of hind leg smooth, rounded, those on tibia about one half size of dorsals of same member; scales preceding femoral pore series smaller than preanals; scales on posterior surface of femur about three times as large as preanals, strongly keeled, strongly mucronate, abruptly decreasing in size immediately behind femoral pore series; scales on posterior surface of femur near insertion surrounded and separated slightly from each other by granules; no postfemoral dermal pocket; lamellar formula for toes, 8-12-16-21-13 (9-11-16-19-14).

Color. Dorsal ground color brown-gray; black nuchal collar narrow, about three scales wide, darker posteriorly and merging with ground color anteriorly; collar with a light, narrow, posterior border about one scale wide, passing onto humerus; a few irregular dark and light markings on neck; a dark line about one scale wide from posterior edge of orbit through upper part of ear to nuchal collar; this line bordered above and below by a light line about one scale wide; back uniform, without markings; a faint dark line from a point above axilla to groin; below this line, sides of body darker;

limbs uniform or very dimly banded; tail with narrow, very dim bands toward tip; throat cobalt blue, lighter anteriorly; chest cream, blue encroaching a short distance on the sides anteriorly; sides of belly azure blue laterally, cobalt blue medially, bordered internally by a black band three or four scales broad, terminating anteriorly a short distance from axilla, and posteriorly involving the region of the groin and encroaching a short distance upon anterior proximal surface of femur; ventral surfaces of limbs, tail and middle of belly cream, immaculate.

Variation. Variation in essential scale characters of the body and in measurements is given in the accompanying table. The variation of the head scales is as follows: Enlarged supraoculars always divided, the scales of the inner row larger than those of the outer row, which is usually incomplete; supraoculars always separated from the median scutes by at least a single series of small scales, frequently by another incomplete series also; one frontoparietal divided in one specimen, both divided in two; posterior frontal contacting interparietal in thirteen specimens, separated by an azygous scale in fourteen, and separated by contact of frontoparietals in four; posterior frontal transversely divided in four specimens, broken into small scales (three or four) in four; anterior frontal one and one half to three and one half times as large as posterior frontal; median frontonasal contacting frontal in ten specimens, separated by an azygous scale in thirteen, and by contact of the two prefrontals in twelve; second canthal contacts subnasal, forcing first canthal above the canthal ridge, on both sides in three specimens, and on one side in three; two complete rows of scales separating subocular from superior labials on both sides in seven specimens, and on one side in two; lateral row of the two rows of scales intercalated between infralabials and postmentals separated from the mental by a partial contact of first postmental and first infralabial in all but one specimen; inner of these two rows terminated under second sublabial on both sides in ten specimens, on one side in three, under the third labial on both sides in five, on one side in three, under the suture between the second and third sublabial on both sides in fifteen, on one side in four.

The dorsal head scales are usually distinctly although not strongly rugose, both in young and in old specimens. Occasional specimens have this rugosity confined to the internasal region and the scales about the supraorbitals.

The coloration is more or less as given by Bocourt (1874). The neckband is narrow, three or four scales wide at the widest point. The two rows of spots down the back, one on each side of the mid-dorsal line, are not regularly present, nor are the spots on the sides usually present. Usually no spotting whatsoever is visible on the back. In one specimen the spots on the sides are arranged in longitudinal series, not in oblique series diverging posteriorly. Some specimens have very light-brown spots scattered over the dorsum. The lateral ventral abdominal areas of males are azure to cobalt blue, bordered internally from opposite the axilla to the groin by a black band some four scales wide. A median whitish abdominal area is six scales wide at the narrowest point; the throat is largely cobalt blue, with some lighter areas sometimes visible as oblique lines. The females are whitish beneath, with irregular blue markings on the throat; sometimes these markings are arranged in oblique lines converging posteriorly.

Habits and habitat. Specimens of this species were collected in Nayarit and Jalisco on rock fences. Some were collected as early as June 10, and at this time the newly born young were running about the fences. It is assumed that the form is ovoviviparous.

Remarks. Boulenger's specimens of *Sceloporus dugesii* described in his monograph of 1897 are not *dugesii dugesii,* but *dugesii intermedius.* However, it appears very probable that the specimens he included with *jarrovii* from north of Rio de Santiago, Jalisco (except one); La Cumbre de los Arrastrados, Jalisco; Ixtlán, Jalisco; and from La Venta, Guadalajara, are all *dugesii dugesii.* Günther's type of *pleurolepis* is in this series. The description of *jarrovii* given by Boulenger, thus considered, is a composite and not descriptive of either species alone. In the table, however, are given a number of rather illuminating data. The femoral pores are fewer in the southern specimens, the fourth toe shorter, the tibia shorter and the snout-ear measurement shorter—all points of difference between *jarrovii* and *dugesii dugesii.* Günther's description of *pleurolepis,* moreover, is entirely applicable to *dugesii dugesii*—much less to *jarrovii.* The very large lateral scales, which he stresses, are much larger in *dugesii dugesii* than in *jarrovii.* Aside from the shape of the frontal, the depiction of which may not necessarily be accurate, the figures accompanying the description of *pleurolepis* illustrates well enough the form *dugesii dugesii.* The femoral pores are 12 in *pleurolepis,* never less than 13 in *jarrovii,* but 9 to 13 in *dugesii*

Measurements and Scale Counts of *Sceloporus dugesii dugesii* Bocourt

Number	2764	2807	2812	2760	2833	2768	2770	2772	2809	2818	2806	2759	2823	2822	2761
Snout to vent	64.8	65.0	70.7	72.0	72.5	79.0	79.0	82.0	82.0	82.0	83.5	83.5	84.0	87.0	87.5
Tail	.....	.....	.....	96.5	.....	.....	.....	.....	.....	.....	120.0	.....	.....	.....	.....
Snout to occiput	13.0	13.5	13.5	13.0	13.0	15.0	15.0	15.6	15.5	15.3	15.3	15.0	15.0	15.2	15.7
Snout to ear	17.0	16.5	16.8	17.0	15.5	18.0	19.0	18.5	19.0	19.5	18.0	18.0	19.0	20.0	19.0
Hind leg	40.0	41.0	41.0	41.0	40.5	43.0	45.0	46.5	46.0	50.0	48.5	50.3	47.5	48.1	46.0
Tibia	13.0	13.0	12.9	12.0	11.9	13.9	13.0	14.4	13.5	14.8	15.0	15.3	14.5	14.0	14.0
Fourth toe	14.2	15.7	14.0	15.0	14.1	.....	15.0	16.0	16.0	17.4	16.9	17.3	17.0	17.1	15.3
Fifth toe	8.0	8.0	7.5	8.1	7.2	8.5	8.0	9.0	9.0	9.7	8.5	10.1	8.7	9.3	8.6
Lamellae, fourth toe	18–18	19–19	18–18	16–17	16–18	19–?	18–18	17–18	18–18	18–18	17–17	19–19	17–17	18–18	18–17
Femoral pores	11–11	9–?	11–12	11–10	11–9	11–10	11–?	13–10	10–10	13–?	11–11	12–?	11–11	13–12	9–10
Dorsals	46	48	46	43	50	45	41	46	48	47	49	43	50	50	44
Ventrals	62	72	69	61	65	68	62	67	61	74	70	66	75	72	61
Scales around body	48	56	52	44	49	48	44	46	52	55	56	46	53	55	45
Scales to head length	8.6	10.0	7.5	7.7	8.0	8.0	7.5	8.3	8.0	8.0	9.5	7.3	9.0	9.2	6.5
Ratio, hind leg to snout-vent	61.7	63.0	57.9	56.9	55.8	54.4	56.9	56.7	56.0	60.9	58.0	60.0	56.5	55.2	52.5
Ratio, fourth toe to snout-vent	21.9	24.1	19.8	20.8	19.4	.....	19.0	19.5	19.5	21.2	20.2	20.7	20.2	19.6	17.4
Sex	♀	♂	♀	♀	♀	♀	♂	♀	♂	♂	♂	♂	♂	♂	♀

dugesii; and the supraoculars are not divided, or are not so nearly equally divided in *jarrovii* as in *dugesii*.

The single specimen of Boulenger's *jarrovii* from Rio Santiago which does not form the type of *pleurolepis* appears actually to be *jarrovii*, judging from the data given in his table. If the locality is correct, then *jarrovii* and *dugesii* overlap each other in their distribution.

In the agglomeration of Boulenger's table for *jarrovii* are also two specimens from San Luis Potosi which have the characters of *minor*, and another from Duvall county, Texas, which has the characters of *poinsettii*.

Range. Along the coastal ranges of western Mexico from southern Nayarit to Colima. (See fig. 22 for distributional map.)

Locality records. Jalisco: near Magdalena (EHT & HMS 2758-2772); near La Quemada (EHT & HMS 2806-2824); near Chapala (EHT & HMS 2833); north of Rio Santiago (type locality of *pleurolepis*) (Günther, 1890; Boulenger, 1897); La Venta, Guadalajara (Boulenger, 1897); Itzatlan (USNM 47887-90, Nelson and Goldman); Jacala (USNM 64658-60, Nelson and Goldman); west of Orendain (AMNH 18454, Paul D. R. Rüthling); El Aguilar Mine, Hostotipaquillo (AMNH 15493, Paul D. R. Rüthling). *Colima:* (Bocourt, 1874; Garman, 1884) (type locality of *dugesii*). *Nayarit:* Ixtlán (Boulenger, 1897).

Sceloporus dugesii intermedius (Dugès)

(Text Figs. 22 and 25; Plate LV, Fig. 2)

Tropidolepis intermedius Dugès, 1870, p. 243 (nomen nudum).

Sceloporus intermedius Dugès, 1877, pp. 29-34, pl. 1, figs. 21-32; Günther, 1890, p. 71.

Sceloporus dugesii (non Bocourt) Cope, 1879, p. 265; *idem*, 1885, p. 403; *idem*, 1887, p. 38; Dugès, 1896, p. 479; Boulenger, 1897, p. 486; *idem*, 1898, p. 915; Cope, 1900, pp. 336, 341-343; ? Werner, 1903, p. 344.

Type locality. Noria, near Zamora, hacienda of D. Epifanio Jimenez (Michoacán).

Diagnosis. A member of the *torquatus* group of the genus *Sceloporus;* dorsal scales, 47 to 54 from occiput to base of tail; femoral pores, 10 to 15; fourth toe shorter than (rarely about equal to) distance from snout to posterior border of ear; ratio of hind leg to snout-vent measurement, 54.7 to 61.1; ratio of fourth toe to snout-vent measurement, 19.5 to 22.1; lateral scales in oblique rows, the median laterals distinctly larger than median dorsals, and with terminal mucrones arising within free edge of scales; head scales not rugose; frontoparietals usually in contact; posterior section of frontal reduced; supraoculars in two rows; a series of dark spots

down back on either side of middorsal line, with a dark line extending obliquely posteriorly from each; black nuchal collar narrow, about three scales wide, with a narrow, light, posterior border; anterior light border indistinct; throat with distinct, oblique, blue bars; sides of abdomen blue, bordered medially by a broad band of black; middle of belly and chest cream; black nuchal collar not confluent on ventral surface; ventral surfaces of limbs and tail cream. Maximum snout-vent measurement, 79 mm.

Description (from EHT & HMS No. 3690, male). Head somewhat depressed; dorsal and lateral head scales with numerous pits,

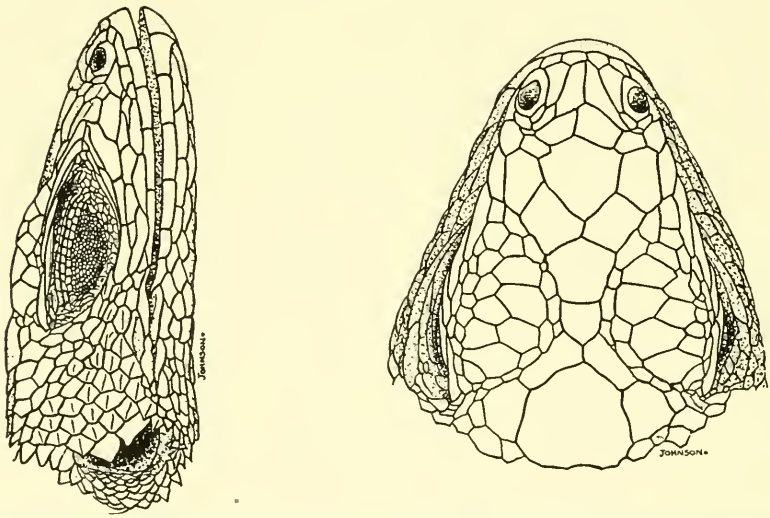

FIG. 25. Head scales of *Sceloporus dugesii intermedius* (Dugès). EHT & HMS 3690, near Acámbaro, Guanajuato; actual head length, snout to occiput, 11.5 mm.

otherwise smooth; a small, rounded parietal on each side; interparietal about four times as large as either parietal; frontoparietals single on each side, rectangular, about two thirds size of parietal, broadly in contact medially; frontal normally divided, the posterior section slightly less than half the area of the anterior section; prefrontals in contact medially; median frontonasal as large as anterior section of frontal, wedged between the two prefrontals; lateral frontonasals about one third the size of median frontonasal, in contact with the latter and both canthals; four internasals, the posterior pair in contact with median frontonasal, the anterior pair separated from rostral by a row of small scales; nasal small, separated from rostral, the part anterior to the nostril about one fourth the diameter of naris; subnasal small; loreal elongate, subequal in

size to subnasal; preocular large, entire; two canthals, the anterior smaller, not forced above canthal ridge nor in contact with lorilabials; subocular followed by one well-differentiated, strongly keeled postocular; supraocular scales in two rows, the scales of the median row somewhat larger than those of the lateral row; one row of small scales between supraoculars and median head scales; one complete row, and another incomplete row on one side, of scales between supraoculars and superciliaries; lorilabials reduced to one row at a point below subocular near its posterior end; four supra- and five infralabials to a point below middle of eye.

Mental with a labial border about two thirds that of rostral, followed by about three pairs of well-differentiated postmentals, the scales of the anterior pair in contact medially; outer row of labiomental scales narrowly separated from mental by a narrow contact of first postmental and first infralabial; inner row of labiomentals terminating below anterior half of third infralabial; gular scales smooth, mostly entire, those on posterior part of throat weakly notched at apex.

Three auricular lobules, smooth, rounded, the upper longest, the middle largest, somewhat larger than preceding scales; scales in temporal region weakly keeled, weakly mucronate; scales between ear and lateral nuchal fold somewhat larger than temporal scales, those on crest of nuchal fold rather strongly keeled and mucronate; lateral nuchal fold not extremely deep; dorsal scales very weakly keeled, not mucronate; lateral scales of body more strongly keeled and mucronate, with numerous lateral denticulations; mucrones of lateral scales not arising at tip of scale, but a short distance within the free margin, leaving a denticulate flange about the posterior edge of the scale; lateral scales considerably larger than dorsals, in oblique rows; ventral scales about half as large as dorsals, smooth, rounded or very weakly notched at apex; preanal scales somewhat smaller than median ventral abdominals; scales on anterior part of chest larger than scales posterior; subcaudals smooth at base of tail, keeled and mucronate distally; postanals enlarged, separated by two small scales; dorsal caudals largest just back of base of tail, about twice as large as median dorsals on back.

Dorsal scales of foreleg subequal in size, those on humerus somewhat larger and about equal in size to median dorsals of body; dorsal scales of foreleg keeled, mucronate, the mucrones arising within the edge of the scale; ventral scales of foreleg keeled and mucronate (except some on lower foreleg), those on lower foreleg

equal in size to dorsals of same member, about two or three times as large as scales on ventral surface of humerus; lamellar formula for fingers, 9-12-16-16-13 (?-11-16-16-?).

Dorsal scales of hind leg strongly keeled, strongly mucronate (more so on tibia), those on femur about equal in size to those on middle of back, those on tibia much larger, slightly larger than median lateral scales on body; ventral scales on tibia smooth, mucronate, about two thirds as large as dorsals of same member; ventral scales of femur smooth, rounded or weakly notched at apex, smaller toward femoral pores, the smallest about equal in size to preanals; scales on posterior surface of femur keeled, mucronate, somewhat larger than preanals, abruptly decreasing in size immediately posterior to series of femoral pores; scales on posterior surface of femur near tail surrounded and separated slightly from each other by granular scales; no postfemoral dermal pocket; lamellar formula for toes, 8-12-17-18-14 (7-12-17-18-14).

Color. General ground color brownish-gray to light brown (pale blue in specimens having shed the scales); black nuchal collar narrow, three or four scales wide, with a narrow, posterior light border, about one scale wide, interrupted medially; light posterior border passing onto humerus, with the part on body narrowly bordered posteriorly with black; light anterior border of black collar broken into spots; an indistinct light line from upper labial region through upper portion of ear across neck to black nuchal collar; a few light flecks on neck anterior to collar; a series of seven small, rounded black spots of indefinite outline on each side of middorsal line, the spots not regularly paired; about an equal number of narrow dark bands on sides of body, one or two scales wide, passing obliquely laterally and posteriorly, each originating at or near one of the dark spots on back; a few scattered light flecks on back; limbs dimly barred or spotted with black or dark gray; tail distinctly banded, the dark bands about two scales wide, the light bands about one; each band darker distally than proximally.

Throat with a pale blue ground color, becoming white near chin; several narrow, oblique, dark blue lines on throat converging posteriorly; extreme anterior part of chest with two bands encroaching medially a short distance from the sides; chest, a narrow band down middle of abdomen four to six scales wide, ventral surfaces of limbs and tail cream; sides of belly azure blue, bordered medially by a broad black band about five scales wide; this black band abruptly

terminating a short distance posterior to axilla, slightly increasing in width in region of groin, encroaching slightly upon anterior proximal surface of femur.

Variation. The variation in head scales is as follows: The supraoculars are always in two rows, or one row and part of another. Occasionally there is but a single scale divided. The frontoparietals contact medially in thirty; an azygous scale separates them in four; and the frontal contacts the interparietal in nineteen. The frontal is transversely divided into three scales in three; the anterior frontal is longitudinally divided in two. The posterior portion of the frontal is always smaller than the anterior, varying from two thirds to one fourth the size of the latter. The frontoparietals are divided into two scales on one side in two specimens. The median frontonasal contacts the anterior frontal in twenty-five; it is separated by an azygous scale in one; the prefrontals contact medially in twenty-seven. The first canthal touches the rows of scales above the supralabials in three specimens; the preocular is separated from these rows in three; the second canthal contacts the subnasal, forcing the first canthal above the canthal ridge, on both sides in sixteen, on one side in six. The lateral row of the two rows of scales intercalated between the infralabials and the series of postmentals is invariably separated from the mental by a partial contact of the first postmental and first infralabial.

Other details of scutellation and proportions are given in the accompanying table.

The coloration is much as described by Dugès (1877), and quite different from that of *d. dugesii,* when specimens of both forms are compared side by side. In dorsal coloration there is but little if any sexual dimorphism. A narrow black nuchal collar about five or six scales wide (maximum) is present; its anterior border either blends more or less insensibly into the ground color of the neck or is marked by a few small whitish spots; its posterior border is always distinct and delimited by a narrow white line one and one half to two scales wide, sometimes broken medially into a series of spots. Behind this on the back follows a double series of about seven, usually rounded, black spots of indefinite outline. On the sides of the body is a corresponding number of oblique black bars, one to one and one half scales wide, divergent posteriorly, each originating from or near one of the median black spots on the corresponding side. These bars and spots are not easily visible on specimens which

have shed their scales, but on all others are easily discernible, although the black is variable in intensity. The tail is distinctly banded, the lighter olive bands narrower than the darker olive or brownish bands.

In males the lateral ventral abdominal areas are usually lavender, sometimes azure blue; these areas are bordered medially by a black band about four scales wide, extending from opposite the axilla to the groin. The medial abdominal area, ventral surfaces of limbs, chest and sometimes the throat and gular regions are cream. The throat region is occasionally pale blue. Oblique, narrow, dark-blue lines traverse the throat. These lines are always quite distinct, both in young and in old.

The ventral surfaces of the limbs and abdomen of females are usually uniformly cream-colored; in some very large specimens a faint indication of the markings of the male is evident. The gular region is marked as in the male, except that the ground color is always cream, not bluish.

Habits and habitat. *S. d. intermedius* was found most frequently on rock fences, occasionally on limestone ledges. They are not wary and sometimes could be caught by hand.

No females have eggs in the oviducts. Very young specimens were frequently collected in August. In the early part of June I collected *dugesii dugesii* on the western coast of Mexico, and at this time the females had no eggs or young in the oviducts. Very small individuals were numerous on rock fences. Although positive evidence is lacking, it is assumed from these data that both subspecies of *dugesii* are ovoviviparous, and that they must give birth to their young during May.

Remarks. As may be discerned by comparison of the above description of *intermedius* with that of *dugesii*, there is ample justification for the recognition of both forms. They differ obviously in the average number of dorsals from occiput to base of tail; the median lateral scales are proportionately larger than the median dorsals in *dugesii*; the head scales are definitely rugose (microscopically) in *dugesii*, smooth in *intermedius*; the frontoparietals rarely contact medially in *dugesii*, but usually do so in *intermedius*; the maximum size is greater in *dugesii* (87.5 mm., snout to vent) than in *intermedius* (79 mm.). The oblique dorsal abdominal bars are absent in *dugesii;* the gular region is rarely rayed in *dugesii* as in *intermedius*, and never distinctly so.

Cope (1900) remarks that *dugesii* (*d. intermedius*) is most closely related to *ornatus*. The additional material of the latter species in

Measurements and Scale Counts of *Sceloporus dugesii intermedius* (Dugès)

Number	3959	3952	3942	3690	2695	3956	3684	3964	3953	3663	3651	3940	3968	3687	3662
Snout to vent	63.0	63.0	64.0	64.0	65.0	65.0	65.5	66.3	66.5	66.5	68.5	73.0	73.9	74.0	78.0
Tail	83.0	85.0	77.0	83.5	89.0	91.5	.....	86.0	86.0	84.0	.....	98.0	.....	.....	.....
Snout to occiput	11.0	11.4	11.2	11.5	12.0	11.8	12.5	11.5	12.0	11.0	13.5	13.0	13.0	12.8	14.0
Snout to ear	14.0	14.0	14.5	15.0	15.5	14.5	16.0	14.0	14.5	14.0	16.3	16.5	16.0	16.0	17.8
Hind leg	38.5	37.0	37.0	38.2	38.0	37.0	40.0	.....	39.5	36.4	41.0	40.5	43.0	40.5	47.0
Tibia	10.5	11.5	11.0	12.0	12.0	10.5	12.0	.....	11.0	10.8	11.5	12.0	12.5	12.0	13.0
Fourth toe	13.5	12.5	13.7	14.2	14.0	13.0	14.0	14.2	14.0	13.0	14.7	15.0	15.0	15.0	16.5
Fifth toe	7.0	7.0	7.0	7.3	8.0	6.8	8.0	7.0	7.1	6.9	8.0	8.6	8.6	8.0	8.5
Lamellae, fourth toe	17–17	18–18	17–18	17–17	17–18	16–18	18–18	18–18	19–18	17–17	17–17	17–19	17–17	17–17	20–20
Femoral pores	10–11	12–13	12–12	14–14	14–15	11–11	13–14	11–12	13–13	10–11	14–15	12–13	13–13	12–13	14–14
Dorsals	50	52	49	53	50	49	51	47	48	53	54	53	50	54	51
Ventrals	60	60	54	66	63	57	58	64	61	60	73	66	63	64	62
Scales around body	53	56	54	56	55	51	53	54	50	54	59	55	54	52	53
Scales to head length	9.0	9.0	8.0	9.0	9.0	8.3	9.5	7.5	8.0	8.0	10.0	9.5	9.0	8.8	8.5
Ratio, hind leg to snout-vent	61.1	58.7	57.8	59.6	58.4	56.9	61.0	.....	59.3	54.7	59.8	55.4	58.1	54.7	59.4
Ratio, fourth toe to snout-vent	21.1	19.8	21.4	22.1	21.5	20.0	21.3	21.4	21.0	19.5	21.4	20.5	20.2	20.2	20.8
Sex	♀	♀	♀	♂	♂	♀	♂	♀	♀	♀	♂	♂	♂	♂	♂

these collections makes still more evident this relationship. There are but few points of difference in scutellation. The supraoculars in *intermedius* are larger, and the posterior section of the frontal is less reduced and never entirely suppressed as in *ornatus*. Limb proportions are quite different in the two species, *ornatus* possessing considerably longer limbs; the fourth toe is also longer. Differences in coloration are apparent, *ornatus* lacking the convergent lines on the throat and the diagonal lines on the sides of the body.

Range. Known only from Guanajuato and northern and central Michoacán. (See fig. 22 for distributional map.)

Locality records. Guanajuato: (USNM 9904-5, 9886, 9893, A. Dugès; Dugès, 1870; Cope, 1879, 1885, 1887); near Acámbaro (EHT & HMS 3651, 3652, 3683-3697, 3940-3948, 3950-3966, 3968-3972, 4041). *Michoacán:* (Boulenger, 1898); Zamora (USNM 47791-2, Nelson & Goldman); La Noria (Dugès, 1877, 1896; Boulenger, 1897); Arroyo Zarco (Dugès, 1896); near Zinapécuaro (EHT & HMS 3662-3666); Pátzcuaro (FMNH 1005 [5 spec.], C. E. Meek; USNM 20145-58, P. L. Jouy; USNM 47219-21, 47223, E. W. Nelson). *Jalisco:* Ocotlán (FMNH 999 [4 spec.], S. E. Meek).

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PLATE XLVII

FIG. 1. *Sceloporus jarrovii jarrovii* Cope. KU 13151, male. Santa Cruz county, Arizona. Snout-to-vent measurement, 80 mm.

FIG. 2. *Sceloporus serrifer* Cope. UMMZ 72890, male. Near Mérida, Yucatán. Snout-to-vent measurement, 101 mm.

PLATE XLVII

PLATE XLVIII

FIG. 1. *Sceloporus torquatus torquatus* Wiegmann. EHT & HMS 3785, male. Near Uruapan, Michoacán. Snout-to-vent measurement, 101 mm.

FIG. 2. *Sceloporus torquatus melanogaster* (Cope). DHD & HMS 691, female. La Colorada, Zacatecas. Snout-to-vent measurement, 119 mm.

PLATE XLVIII

PLATE XLIX

FIG. 1. *Sceloporus bulleri* Boulenger. USNM 64664, female. La Laguna, Jalisco. Snout-to-vent measurement, 83.5 mm.

FIG. 2. *Sceloporus mucronatus mucronatus* (Cope). EHT & HMS 2096, female. Near Toxtlacuaya, about 18 miles west of Jalapa, Vera Cruz. Snout-to-vent measurement, 95 mm.

PLATE XLIX

PLATE L

FIG. 1. *Sceloporus mucronatus omiltemanus* (Günther). EHT & HMS 3094, male. Two miles west of Acultzingo, Vera Cruz. Snout-to-vent measurement, 86.5 mm.

FIG. 2. *Sceloporus mucronatus omiltemanus* (Günther). MCZ 33904, male. Chilpancingo, Guerrero. Snout-to-vent measurement, 95 mm.

PLATE L

PLATE LI

FIG. 1. *Sceloporus poinsettii* Baird and Girard. LMK 24283, female. Gatton's Park, Grant county, New Mexico. Snout-to-vent measurement, 91 mm.

FIG. 2. *Sceloporus cyanogenys* (Cope). EHT & HMS 5053, male. Arroyo Los Olmos, three miles southeast of Rio Grande City, Starr county, Texas. Snout-to-vent measurement, 132.5 mm.

PLATE LI

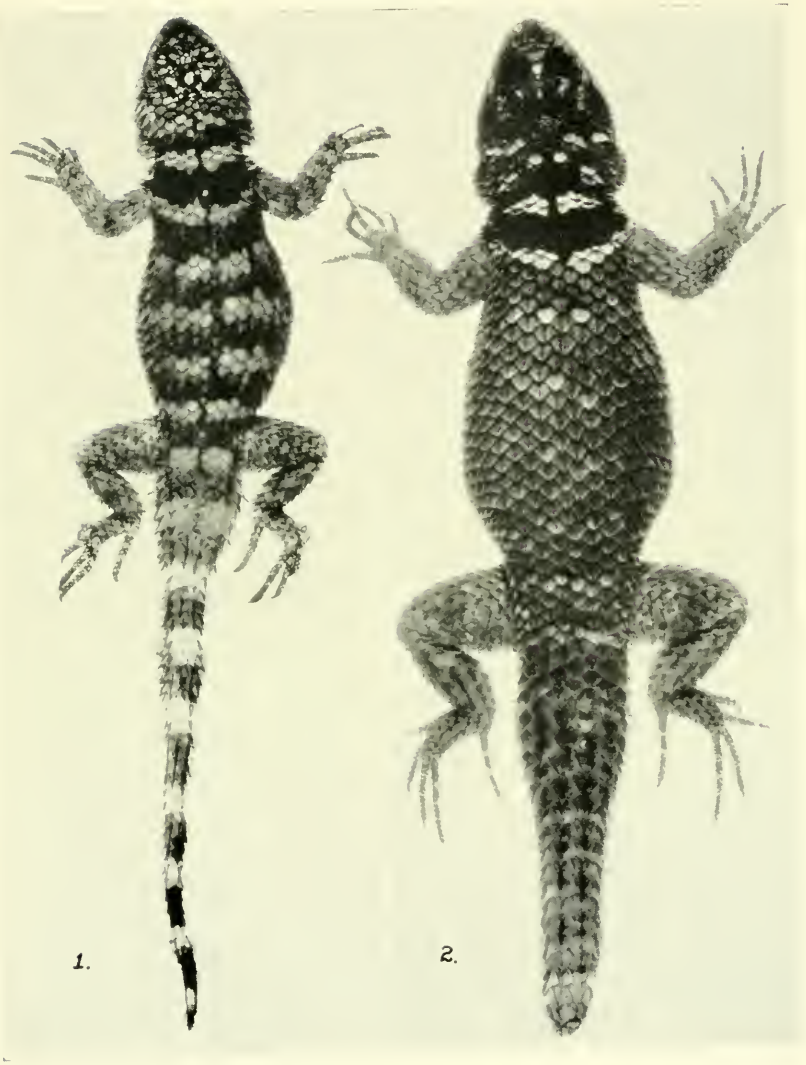


PLATE LII

FIG. 1. *Sceloporus lineolateralis* Smith. EHT & HMS 4332, male. Six miles northeast of Pedriceña, Durango. Snout-to-vent measurement, 71 mm.

FIG. 2. *Sceloporus lineolateralis* Smith. EHT & HMS 4363, female. Six miles northeast of Pedriceña, Durango. Snout-to-vent measurement, 73 mm.

PLATE LII

PLATE LIII

FIG. 1. *Sceloporus jarrovii immucronatus* Smith. EHT & HMS 500, male. Near El Pinalito, Hidalgo. Snout-to-vent measurement, 86 mm.

FIG. 2. *Sceloporus jarrovii minor* (Cope). EHT & HMS, 4207, male. Near San Felipe, Guanajuato. Snout-to-vent measurement, 97 mm.

PLATE LIII

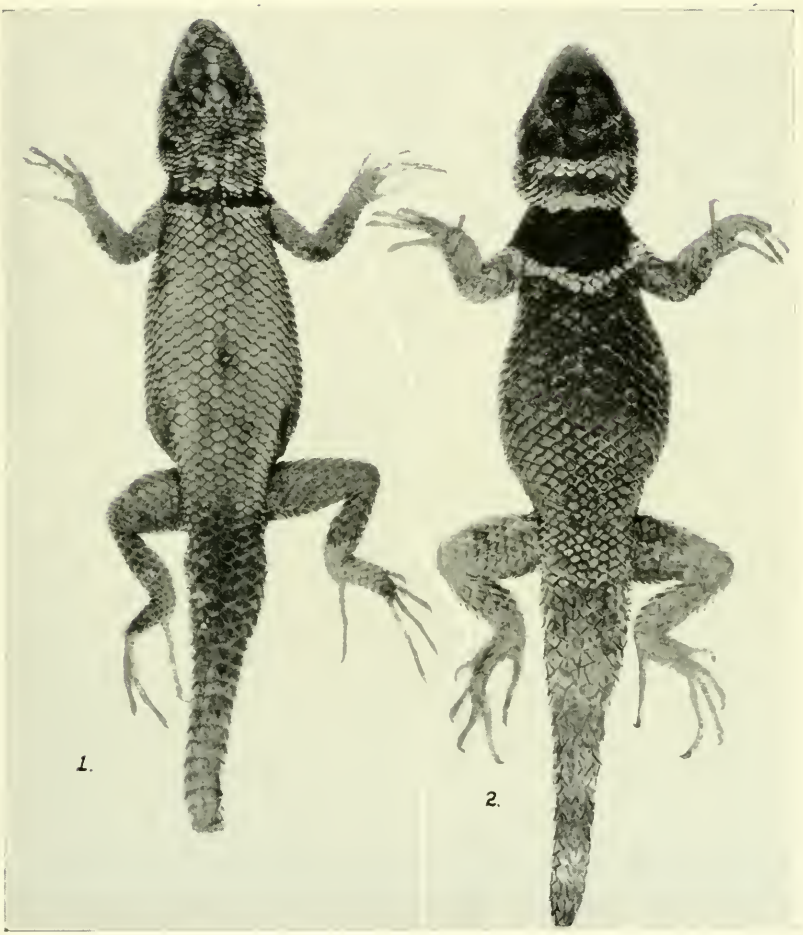


PLATE LIV

FIG. 1. *Sceloporus ornatus ornatus* Baird. EHT & HMS 4420, male. Near Saltillo, Coahuila. Snout-to-vent measurement, 72.5 mm.

FIG. 2. *Sceloporus ornatus caeruleus* Smith. DHD & HMS 350, male. Five miles south of San Pedro, Coahuila. Snout-to-vent measurement, 75 mm.

PLATE LIV

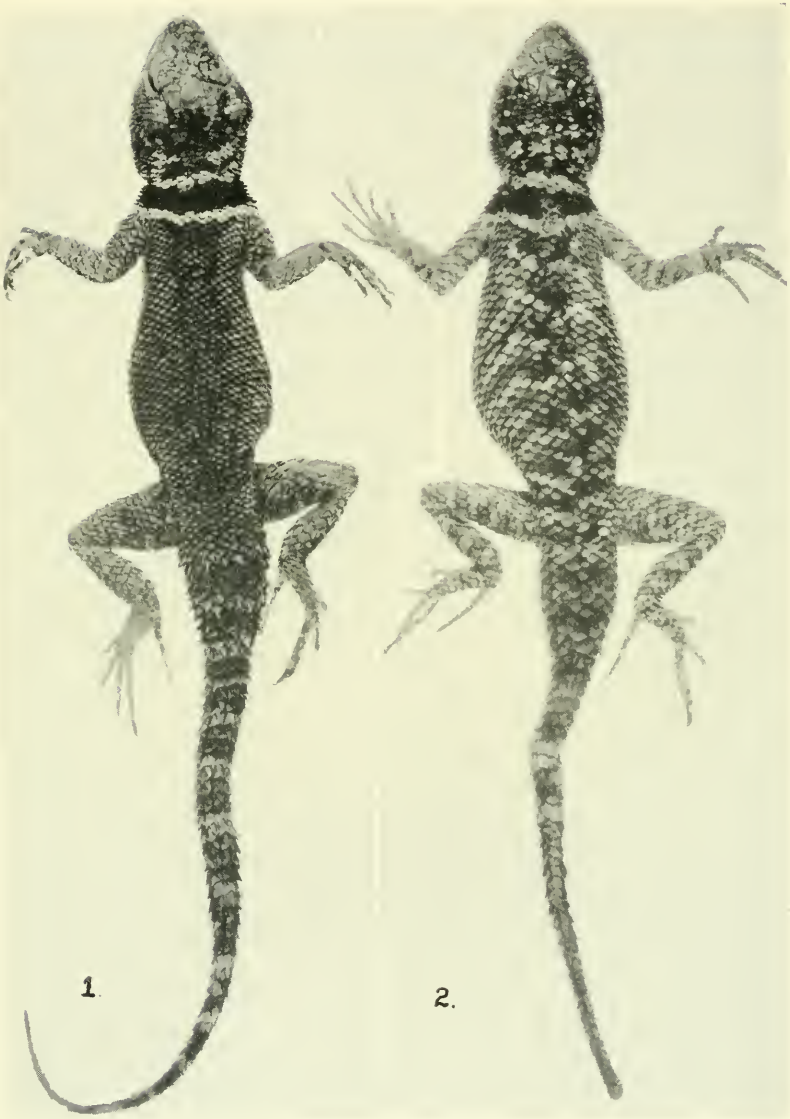
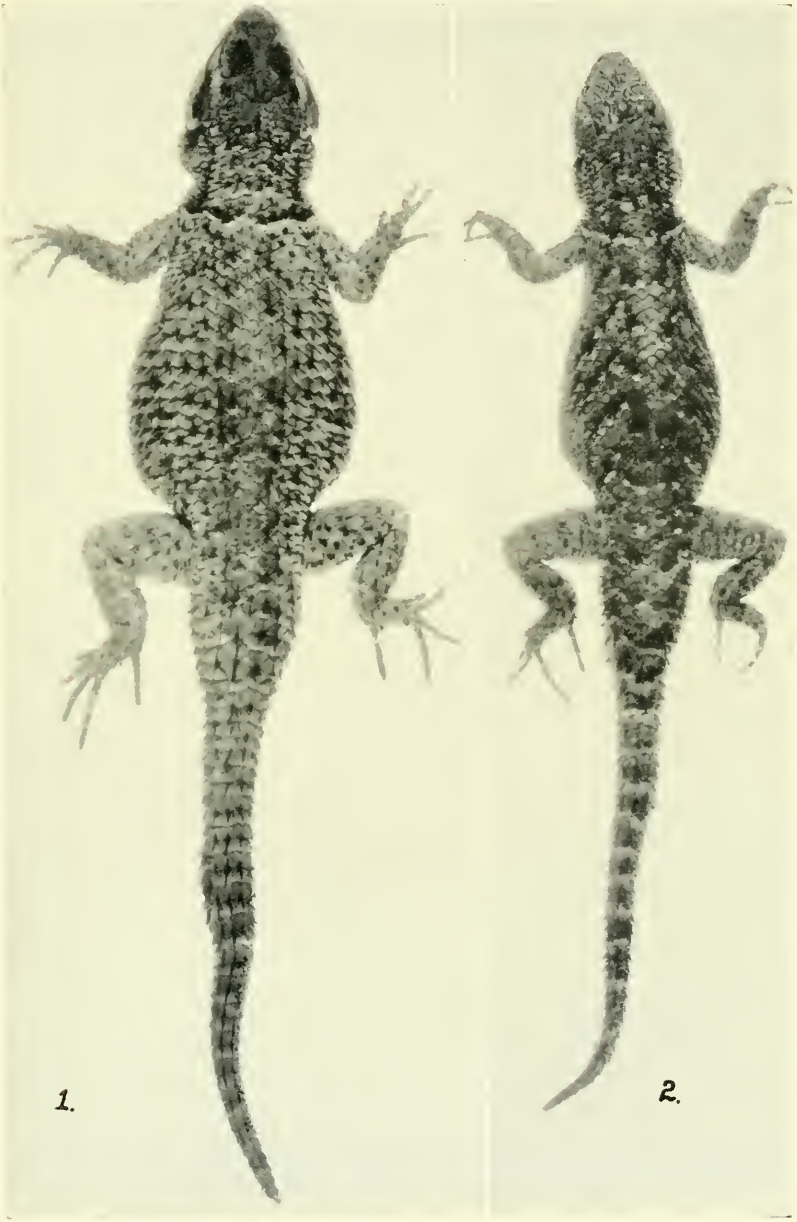


PLATE LV

FIG. 1. *Sceloporus dugesii dugesii* Bocourt. EHT & HMS 2770, female. Near Magdalena, Jalisco. Snout-to-vent measurement, 79 mm.

FIG. 2. *Sceloporus dugesii intermedius* (Dugès). EHT & HMS 3961, female. Near Acámbaro, Guanajuato. Snout-to-vent measurement, 68 mm

PLATE LV



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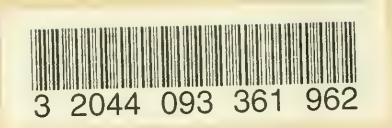
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